

kilobaud

# MICROCOMPUTING<sup>T.M.</sup>

*for business . . . education . . . FUN!*

## **"On the Air"**

A radio station  
computerizes.  
P. 22

## **Two H8 Projects:**

Timer for the  
darkroom. P. 34  
Expansion  
chassis. P. 40

## **Inexpensive Interconnection**

Going multi-user  
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Do it in 8-part  
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## **Kid Power**

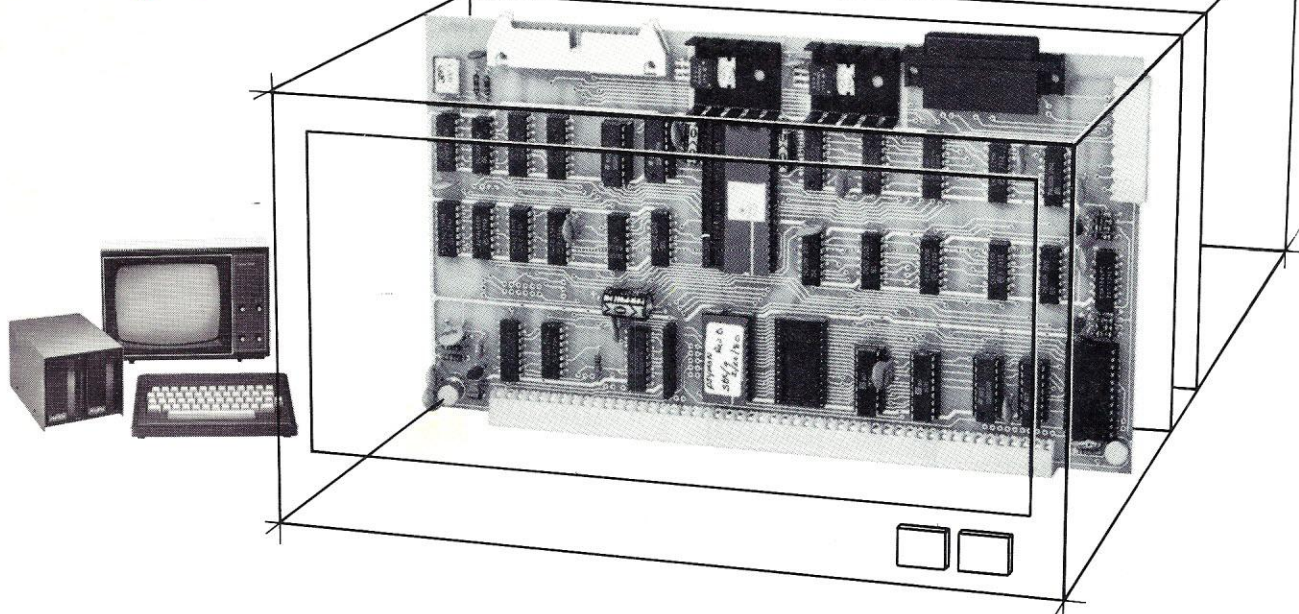
Never too old —  
nor too young — to  
learn. P. 204





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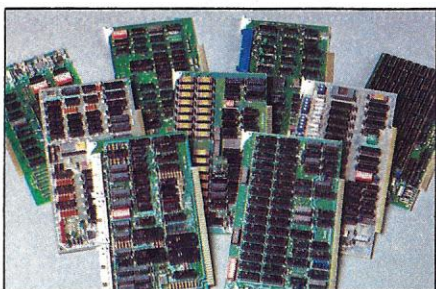
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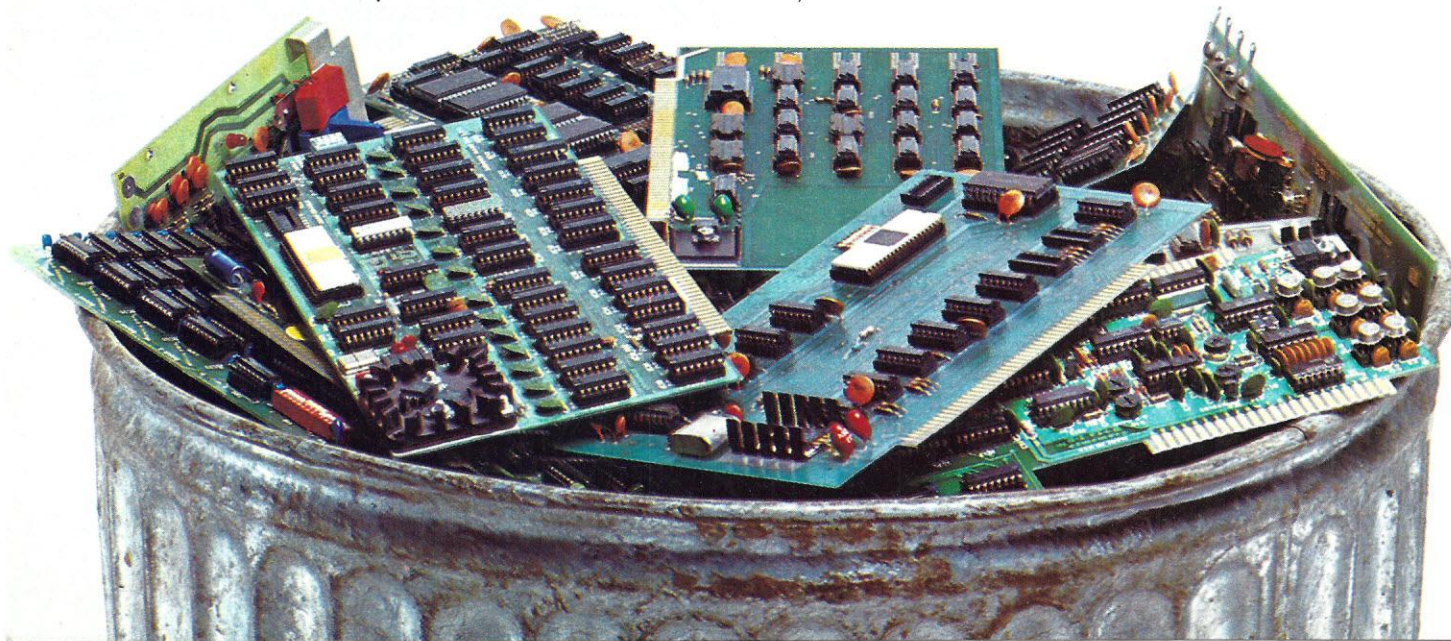
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Cover: Program Director Tim Tobin on the air at WSCV/WSLE in Peterborough NH. Photo by Reese Fowler.

## micro info

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Contributions in the form of manuscripts with drawings and/or photographs are welcome and will be considered for possible publication. We can assume no responsibility for loss or damage to any material. Please enclose a self-addressed, stamped envelope with each submission. Payment for the use of any unsolicited material will be made upon acceptance. All contributions should be directed to the *Microcomputing* editorial offices. "How to Write for *Microcomputing*" guidelines are available upon request.

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## Subscription problem or question:

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Kilobaud *Microcomputing* (ISSN 0192-4575) is published monthly by 1001001, Inc., 80 Pine St., Peterborough NH 03458. Subscription rates in U.S. are \$18 for one year and \$45 for three years. In Canada: \$20 for one year and \$51 for three years. In Europe, send 89.-DM in Eurocheque or send credit card information to: Monika Nedela, Markstr. 3, D-7778 Markdorf, W. Germany. South African Distributor: KB Microcomputing, PO Box 782815, Sandton, South Africa 2146. All other foreign subscriptions are \$23—one year only (surface mail). Second-class postage paid at Peterborough NH 03458 and at additional mailing offices. Phone: 603-924-3873. Entire contents copyright 1980 by 1001001, Inc. No part of this publication may be reprinted or otherwise reproduced without written permission from the publisher.



# PUBLISHER'S REMARKS

## Primal Scream

Back in the July 1979 issue, I wrote about some of the problems we'd been having with our Prime 300 minicomputer. We invested in the system so we would have in-house computing to handle the subscribers' labels and renewals, payroll, bookkeeping, reader service requests, and keep track of potential advertisers, potential subscribers and the article inventory. Now it looks as though the approximately \$250,000 we spent for the system has been a complete waste.

Despite my writing to Prime several times, calling them and even mentioning the problems in the magazine, Prime has been unresponsive. I talked with Prime representatives about this at NCC, and though they promised action, nothing has happened yet. I am getting the impression that once they sell a system they care less what happens to the customer.

In the July editorial I reported that we got about 20 percent of what I was led to expect out of the Prime. We gave up on using it for subscriptions, payroll, bookkeeping, article records, ad records and potential subscriber records. We were using it for reader service requests, but those are so far behind as a result of the Prime's breaking down repeatedly that we have moved that function to a service bureau.

About the only job left for it was keeping a mailing list for our "Microcomputing Industry Newsletter." When that simple chore held up the mailing of this publication for three weeks, we moved it to a TRS-80 and had little more for the Prime to do. We had also been trying to handle the daily orders for books and Instant Software, but that, too, got a month behind and was moved to a Midwest Scientific microcomputer.

These days we are doing most of our in-house computing on either the Midwest system or our TRS-80 systems. The service contract on the Prime is over \$750 per month, and you can buy a lot of TRS-80s in a year for that. We have fewer breakdowns with the TRS-80 systems than with the Prime.

I don't know what experience others are having with the Prime. Someone must be happy because Prime keeps building new buildings and growing. Sales in 1979 were over \$150 million, and the growth rate was over 50 percent in the last year. Surely all of Prime's customers can't be as disappointed as we have been with the performance we expected from the Prime.

The original idea, as discussed with Prime, was to buy the system they said we needed and have it programmed for publishing-house use. We then intended to sell Prime systems, OEM, to other publishers, figuring that we might be able to sell and program 50 systems or more a

year. Now we're looking around for a way to dump our Prime 300 because it can't handle the work required even by a relatively small publishing house.

## Job Opportunities

Two nearby colleges are still looking for computerists with formal educational backgrounds for their microcomputer schools. Contact Dean Coles, Franklin Pierce College, Rindge NH 03461, or Dean Jones, Nathaniel Hawthorne College, Antrim NH 03440. Here's an opportunity for you to help set up a computer department and train the people who will become the future chief executives in the growing microcomputer field.

Positions are open in our publishing and software departments. We need book editors, editors for both *Kilobaud* and "80" magazines, marketing people, sales-oriented people, hams to help test new equipment and hardware and software people for Instant Software. We're looking for people who have leadership

qualities to move up to middle and top management.

Send a letter telling us what you have done, what you can do for us and what we can do for you to Al Thulander, *Microcomputing*, Peterborough NH 03458. Not only will we expand the magazine and book-department staffs, we plan to publish three new magazines, all of which will need full staffs.

## Mailing Schedule Changed

The mailing schedule for *Kilobaud Microcomputing* has been changed a few days to bring the cover date more in line with the date of receipt of the magazine. The publication of three magazines a month forced us to shift around our production, printing and mailing schedules so that one magazine could go to press every ten days. 73 goes to press first each month, followed by *Kilobaud Microcomputing* and 80 *Microcomputing*. With 150- to 250-page magazines coming out every ten days, everyone is kept busy.

Sherry Smythe

# OUTPUT FROM ISI

Instant Software has released its first disk programs and sent samples to the ISI reps around the world. Most programs will continue to be released on cassettes, though, even if they will be used with disk systems. This makes sense when you consider that cassettes are less expensive than disks.

Cassette tapes are less likely to be damaged in shipment or on display than disks. They are less likely to be accidentally influenced by stray magnetic fields, and they take up less space. Disk packages make sense when the price of the program is high enough so the cost difference between cassettes and disks is a small matter.

ISI disk programs are packaged in a three-ring binder and generally have more documentation than the cassette packages. The first disk release is an energy audit program, which should interest realtors since laws that could prohibit the sale of a building without such an

audit are under consideration. This package will also be useful for energy-conservation consultants.

## Asian Trip

For about \$2000 you can sign up for the coming IEEE tour of consumer electronics shows in Japan, Taiwan, Korea and Hong Kong. This trip will start about the first of October and be back in three weeks. It takes you to four electronics shows where you will be able to meet businessmen interested in importing your products, and the prices are right. If you want to go, please drop me a line and I'll get you full information. Wayne is working on a special trip to add short visits to Macao and even China, if possible.



# PET-POURRI

## Tape Drive with a Counter

Someone finally did it. There is now a cassette drive with a counter available for the PET at a reasonable price. The D&R S2545 cassette system is supplied by D&R Creative Systems, PO Box 402B, St. Clair Shores MI 48080, and sells for \$83 plus \$3 shipping and handling. The cassette system consists of a self-contained, epoxy-potted interface module and a Sanyo M2545A recorder.

The module plugs into the cassette port at the rear of the PET and fits flat against the back panel. Because of the module's size, it cannot be used with the cassette interface inside the PET. The recorder is specially modified to sense when the recorder buttons are pressed and operates identically to the PET cassette drives with full program control. Even with the slight modification, the cassette recorder is still fully warranted by Sanyo.

Four cables from the interface module connect to the recorder REM, EAR, MIC and SENSE connectors; the latter is mounted inside the unused battery compartment. In order to connect the SENSE line connector, you must remove the battery compartment cover from the Sanyo recorder.

The D&R cassette system provides two methods of program location. Using the digital counter, programs can index and quickly relocate with their beginning and ending counter values. Also, the D&R system can locate programs audibly using the fast-forward cuing features of the Sanyo recorder. While the recorder is in the Play mode, depress the Fast Forward button and you can hear the programs pass by the recording head at the fast-forward cuing speed. You can clearly detect the 10-second leader at the start of each program.

In testing a D&R cassette system on my PETs, I found no compatibility problems when switching tapes between the D&R cassette and three different Commodore C2N drives. But D&R does warn of possible incompatibilities due to head alignments of the Commodore drives since Commodore changed its cassette unit three times after the PET was introduced. I also found no problems with special settings of

the volume and tone controls—you merely turn both clockwise all the way and let the D&R interface do its job.

The only disadvantage of the D&R cassette system is that you can't connect the MIC and EAR cables to the recorder at the same time. Whenever you switch between reading or writing a tape, you must switch the cables to the Sanyo recorder. This slight inconvenience is a small price to pay when you consider the digital counter and fast-forward cuing features provided. Also, you can still use the Sanyo recorder as a standard recorder with built-in microphone and automatic level control.

## Programming Tips

Ever save a machine-language program on tape and forget what memory locations it uses? Try this simple trick on systems with the new ROMs. Place the tape in the cassette drive and type OPEN 1 instead of LOAD. This will read the file header but will not load the program into memory. Now type SYS 64785 to enter the machine-language monitor, followed by M 027A,0290 to display the first 24 bytes of the tape buffer. The format of the data found in the buffer is shown in Example 1.

Locations 027B-027E indicate the starting and ending addresses for any program file. Remember that the addresses are in 6502 address format, low byte first followed by the high byte. All values are in hexadecimal.

Here's a simple programming trick for anyone with a printer to allow selectable output for either the printer or the display. Instead of having separate print statements for both the printer and the display, try this. After deter-

|           |         |                          |
|-----------|---------|--------------------------|
| Byte 1    | 027A    | File type (01 = program) |
| Bytes 2/3 | 027B-7C | Program starting address |
| Bytes 4/5 | 027D-7E | Program ending address   |
| Bytes 6+  | 027F-   | File name                |

Example 1.

OPEN 5,4 opens a logical file (#5) for output to the printer (device #4)  
OPEN 5,3 opens a logical file (#5) for output to the display (device #3)

Now simply code all PRINT statements that are to be selectable as printed or displayed as:

PRINT#5, ".....text....."

and all output will automatically switch as selected without any additional print statements, flag testing, etc. Any normal PRINT statements will still always appear on the display screen as usual.

Example 2.

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mining whether the user wants printed or display output, open a logical file for the appropriate device (see Example 2).

## Creative Software Products

Creative Software, PO Box 4030, Mountain View CA 94040, has programs available for the PET at reasonable prices. They include Household Finance and Utility packages as well as various joystick-interface games. Most of these programs will run on any model PET, but check each program to make sure it will run on your system. All the programs are well written and provide an excellent user interface to help people unfamiliar with the programs.

The Household Finance package sells for \$20 and consists of two programs designed to record and analyze household expenditures and income. Part I inputs and lists budget items while creating a record on cassette tape of all items entered. Part II sums the data tapes created using part I and presents overall patterns of spending.

Part I allows inputting data for a new month, or updating and adding data to a previously recorded month. You enter the date, amount, category code, payment method (or check number) and any brief description for each item to be recorded. Item descriptions are limited to 29 characters and cannot contain commas. To classify each item, sixteen category codes are available: Auto, Mortgage, Clothes, Entertainment, Education, Food, Gifts, Household, Income, Taxes, Medical, Insurance, Savings, Utilities, Vacation, Miscellaneous. If you have over 100 items in a month or run out of memory, you can use more than one tape for any month.

Part II then reads the data files created by part I and prints a table of the totals for each category. A nice feature of this program is a graphic display of a spending profile that shows what percentage was spent in each category. Other options allow displaying various category totals or adding additional data from other months.

The Household Utility packages are \$15 each for three programs on a tape. The first package includes a program to help compare the trade-offs between buying a house and renting an apartment. It takes into account such items as inflation, property taxes and tax deductions. Another program on this tape computes various loan calculations to find monthly payments, length of a loan and how much you can afford to borrow with a monthly payment limit.

The second Household Utility package is more useful. It includes a Compound Interest program to solve savings-account investment problems concerning the future value of an account. An Amortization program calculates the usual costs associated with a mortgage loan. It displays the current amount paid to interest and principal as well as the total amount paid in interest and the remaining balance on the loan. The last program calculates the cost per mile of driving an automobile. The program takes into account the purchase price of the car, licensing

fees, routine maintenance and repairs, insurance, number of miles driven, gas expenses and the approximate resale value.

The Household Finance package can be valuable in establishing and maintaining an effective home budget. However, the chore of recording every expenditure and income may be overburdening if you use tape data files. If you have disk drives available you can modify the program to use disk data files instead of tape. This enhances the excellent features already provided by these programs while drastically reducing the time to read or write data files.

In the January issue I mentioned the joystick interfaces available from Creative Software. The dual joystick interface connects two Atari joysticks and sells for \$45 with two demo programs and documentation. The joysticks are not included and cost an additional \$15 each if you don't already have an Atari video game.

The interface consists of a sealed, 1 x 2 x 3 inch plastic box. A user port connector is mounted on one side and two subminiature D connectors for the joysticks are mounted on the opposite side. The interface plugs into the PET user port, and either or both joysticks are plugged into the appropriate connectors.

The interface is compatible with all *Cursor* magazine programs that use joysticks for control. However, the user port connector is not "keyed," so you must plug it in right side up. Be careful not to exert any downward pressure on the interface box to avoid damaging the PET main logic board.

Since most games using joysticks also provide sound effects, I was surprised not to find any connector provided for sound output. You can remedy this by adding a miniature phone connector wired to the CB2 and ground lines of the user port connector. There is plenty of room in the interface box for adding this connector and a dropping resistor or miniature switch.

A Fairchild joystick sells for \$35 and comes wired directly to a user port connector ready to use. The connector is not keyed, but the top side is identified by a label. The wiring connections are protected on the back of the connector. Multiple actions are possible with the Fairchild joystick.

Both joystick interfaces come with a simple write-up describing their installation and programming. Additional programs are available that allow using either interface or the numeric keypad for motion control. They sell for \$10 each and include:

Breakout—the standard game with paddle-size options.

Road Race—a good 2-player road-race game with three separate racetracks (requires dual joysticks).

Seawolf—a shooting-gallery-type game; you try to sink various ships.

Tag—a 2-player game (requires dual joysticks).

Sketchpad and Maze—sketchpad allows drawing graphics with the joystick; Maze tests your maneuverability through a maze.

All programs run on any model PET. Several are written in machine language or have machine-language routines for faster graphics motion and control.

## TIS Workbooks

TIS Workbooks are valuable for newcomers to the PET. There are currently six volumes in the series covering the PET in detail with examples, sample programs and short exercises. Spaces are provided within the text to record notes and routines.

Since the books were written for the original 8K PET, errata sheets are now included for the new ROMs and the 16K/32K machines. The individual volumes sell for \$3.95 to \$4.95 each; the entire set is \$19.95, plus shipping, from Total Information Services, PO Box 921, Los Alamos NM 87544.

*Workbook 1—Getting Started with Your PET*, written primarily for people with little computer programming experience. It tries to provide enough information to allow the reader to input, run, save and load programs. It introduces the fundamentals of PET BASIC: calculator and program modes, data input and output, data representation and program storage on cassette.

One obvious error appears on pages 6-4 and 6-5. Several examples determine the amount of memory space used by different BASIC variables. Since arrays are used, the manual incorrectly states that floating-point variables take five bytes, integers take two and strings take three. This is only true for elements within an array. Individual variables are always seven bytes regardless of the variable type. Using a single integer variable (B%) uses the same space as a single floating-point variable (B). In fact, you can actually waste space by using the extra percent signs whenever the variable name is used in the program.

*Workbook 2—PET String and Array Handling* describes the features and limitations of arrays and subscripted variables. It covers string operations and related string functions in detail. Problem exercises help you better understand strings and arrays, while the index gives a detailed description of the various PET "character sets."

One word of caution for those with an older 8K PET and the original ROM set: pages 4-5 and 4-6 of this volume do not warn of the illegal use of a zero length in the LEFT\$ and RIGHT\$ string functions. This will result in an error on the old ROM set. The newer PETs and the upgrade ROM for the 8K PET now allow zero lengths in these functions without causing an error.

*Workbook 3—PET Graphics* covers the cursor-control characters, character sets, low- and high-density plotting, bar graphs, sketching and reverse video. The index includes complete listings for several programs developed in pieces throughout the workbook.

*Workbook 4—PET Cassette* reviews loading and saving program files and discusses all aspects of data file handling. It covers the OPEN and CLOSE commands along with transferring string and numeric data to and from tape data files. Status checking is also included with two application programs and information on cassette performance.

(continued on page 18)



# MicroQuote

Your personal computer becomes  
a window on Wall Street.



MicroNET, the personal computer service of CompuServe, now offers MicroQuote, a comprehensive securities information system.

With MicroQuote you can gain information from a data bank of over 32,000 stocks, bonds and options from the New York, American, OTC and major regional markets plus Chicago options. MicroQuote contains price and volume data from January, 1974 with cumulative adjustment factors and dividend information from January, 1968.

You can determine indicated annual dividends, earnings per share, shares outstanding, BETA factors, open interest on options and amount outstanding on debt issues. MicroQuote can provide issue histories on a daily, weekly or monthly basis and even performs certain statistical analyses on the data. It's a vital tool for any investor.

#### It's just part of the MicroNET service

MicroNET also allows error-free downloading of software via the new software exchange and executive programs (now available for the TRS-80®, Apple II® and CP/M® systems). It also provides electronic

mail service and can be accessed with a 300 baud modem via local phone calls in more than 175 U.S. cities. Write for full details on how your microcomputer can control one of the nation's largest and most sophisticated time-sharing computer centers for about 8 cents a minute!

TRS-80 is a registered trademark of Tandy Corporation  
Apple II is a registered trademark of Apple Computer, Inc.  
CP/M is a registered trademark of Digital Research

Regional distributors and local dealers wanted.  
Inquire to Dept. R

Software authors: MicroNET seeks to license quality programs for software exchange. Write to Dept. S

**MicroNET™**

Mail to:  
**CompuServe**

Dept: K  
Personal Computing Division  
5000 Arlington Centre Blvd.  
Columbus, Ohio 43220

✓ 147



# NEW PRODUCTS

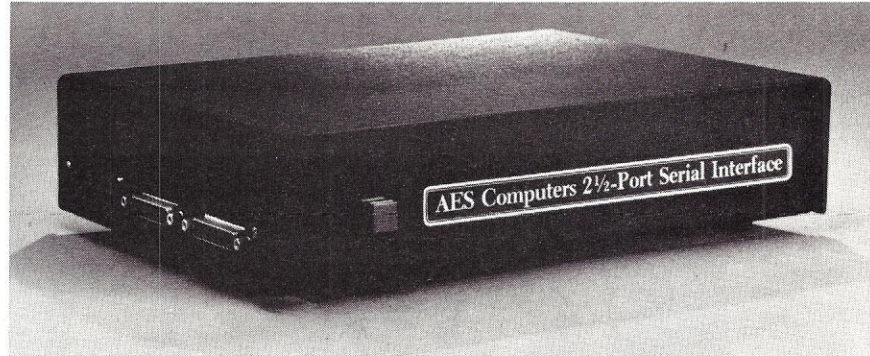
## Lowercase for Apple II

*Reviewed by Art Little, ISI staff*

Now you can add uppercase/lowercase capability to your Apple II with the newly released Keyboard Expander. Unlike other products that use such keys as ESCAPE or CONTROL to indicate case, this hardware/software modification actually allows you to use the SHIFT keys, just as on a conventional typewriter.

The hardware change to the Apple II is a simple one-wire modification requiring a single solder point. The software modification is a totally transparent machine-language routine that augments the capabilities of the monitor while avoiding its uppercase conversion code. This routine permits the use of all Apple II characters and editing functions of the monitor as well as a capitals lock and shift lock. The software occupies only 1/4K and can be used on any size system; there are no system constraints with this product.

It is compatible with general display techniques, such as Paymar's LCA or Apple's contributed high resolution character generator, that display ASCII correctly. An Inverse mode option is included for those who do not already have a display method for uppercase/lowercase. The Keyboard Expander is also totally compatible with DOS, allowing the use of uppercase/lowercase in TEXT files, PRINT and REM statements within BASIC programs and DOS file names, as well as in Immediate mode. Full documentation of both the hardware and software modification, as well as a floppy disk containing



*AES Computer's 2 1/2 Port Serial Interface.*

copies of the routines, is included with the package. Price is \$20.

C & H Micro, PO Box 249, Clifton Park NY 12056. Reader Service number 477.

## Light Pen for Apple II

A self-contained light pen that plugs directly into the Apple has been released by the 3-G Company, Rt. 3, Box 28a, Gaston OR 97119. The 3-G Light Pen makes it possible to bypass the Apple's keyboard and interact directly with the information displayed on the CRT screen. The light pen adds versatility to most graphics programs and makes possible unique games.

The user can make a selection from a menu displayed on the screen by using the light pen. This type of interaction makes it easy for the non-computer-oriented person to use an applications program. Another use of the pen is in educational programs as a teaching aid or a game for a young child.

The 3-G Light Pen is completely assembled and ready to plug into the Apple game paddle port. A demonstration game cassette, sample program and complete programming instructions are included with the pen. Price is \$32.95, plus \$1.50 for postage and handling; \$6 for foreign orders. Reader Service number 480.

## Serial Interfaces

AES Computers, 118 S. Loara, Anaheim CA 92802, has introduced 2 1/2 and 4 1/2 Port Serial Interfaces, which provide two or four serial communication controllers, respectively. A flexible interface bus to the host com-

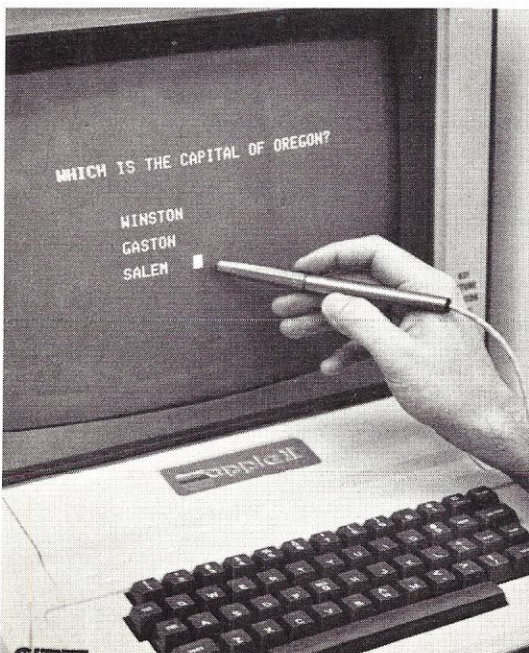
puter can be adapted to various microprocessors with plug-in modules and adapter cables for TRS-80, Apple II, Exorciser, S-100, Multibus, STD Bus and others. The self-contained unit will operate 8080, Z-80, 6800 and 6502 in memory-mapped or I/O-mapped environments. Using the 8251A serial controllers, the interface supports synchronous communication modes to 64K baud and asynchronous communication modes to 19.2K baud. All aspects of the communication mode for each channel are software programmable.

The serial interface permits rapid implementation of advanced serial communication techniques for small computers. By providing two RS-232C interfaces and one isolated current-loop interface, the 2 1/2 Port (\$395) unit quickly expands small computers to build multiterminal or multiprocessor systems suitable for business, scientific and engineering applications. The 4 1/2 Port (\$695) supports four RS-232C interfaces and two current-loop interfaces. Reader Service number 478.

## Studio II Conversion Package

The Studio II conversion package is designed to allow the owner of an RCA Studio II video game to convert his game unit into a simple microcomputer. The package consists of a PROM card, a RAM card, a backplane card, all the instructions necessary to install and operate the unit and six issues of the Studio II user's newsletter, *MicroStudio News*.

The backplane plugs into the Studio II game cartridge slot, and the PROM and RAM cards plug into the backplane. The four connectors on the backplane are mounted but not soldered. The PROM card and RAM card are completely assembled (except for



*Apple II light pen at work.*



two 2114 RAM ICs) and tested. Two signals must be brought out from the Studio II for the RAM card. The package provides 1560 bytes of RAM and 512 bytes of ROM and includes the pre-programmed PROM containing the Monitor program. Price is \$160.

ARESCO, PO Box 1142, Columbia MD 21044. Reader Service number 489.

## Disk Protection

The C S S N BACKUP subsystem is a complete hardware/software package for the protection of disk-stored data. The off-line storage medium is a 13.4 megabyte capacity magnetic tape cartridge, making BACKUP ideal for use with high-capacity Winchester disks. BACKUP also offers the advantage of file-by-file backup, which allows you to restore just those files which were lost, rather than the entire disk.

BACKUP comes in a rack-mounted unit with a Z-80A/S-100-compatible interface board, a DEI cartridge tape drive and a CP/M-compatible software utility, featuring the file-by-file SAVE and RESTORE commands. Price is \$2995.

C S S N, 120 Boylston St., 4th Floor, Boston MA 02116. Reader Service number 493.

## TRS-80 Speech-Recognition System

Now TRS-80 users can program their computers to respond to spoken words with the TRS-80 Voxbox, a speech-recognition system from Radio Shack, 1300 One Tandy Center, Fort Worth TX 76102. Words or phrases may be used to enter data, control and instruct the TRS-80 without having to type on the keyboard. The Voxbox can be programmed with up to 32 words. The user decides what words are to be used, and what they do (the action caused or data provided) is written into the program.



Radio Shack's TRS-80 Voxbox.

The Voxbox should correctly recognize 85-95 percent of the words used, provided the user speaks clearly and distinctly. However, Radio Shack recommends that the unit be used primarily for entertainment and experimentation. The unit requires Level II 16K RAM and cassette recorder. A machine-language "driver" program and three demonstration programs, owner's manual and a push-to-talk dynamic microphone are supplied with the unit. Price is \$169.95. Reader Service number 475.

## AIM-65 Card File

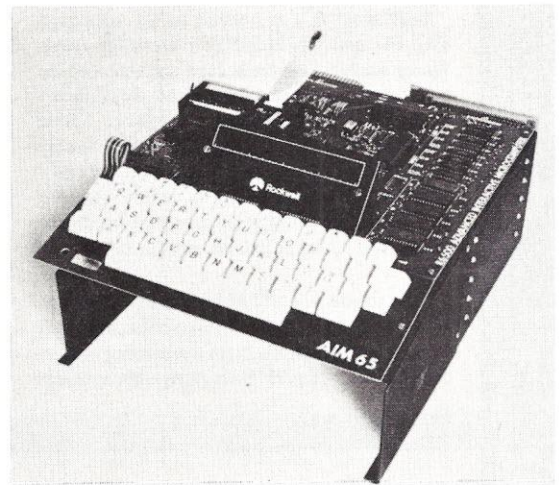
The MTU K-1005A-A Card File integrates the AIM-65 computer, keyboard and a series of expansion boards into one compact, portable unit, complete with motherboard. Drawing no power, the unbuffered motherboard utilizes the AIM bus structure to carry expansion connector signals to up to four additional boards. A fifth undedicated position is provided for a board not on the bus.

The card file features a U-shaped black anodized aluminum frame measuring  $15\frac{1}{2} \times 11\frac{1}{2} \times 4\frac{1}{2}$  inches (exclusive of AIM). To keep the expansion bus noise-free, the motherboard is a double-sided printed circuit board with groundplane. Price is \$95, including motherboard and user manual. An applications motherboard (\$29) is optional. Other card files are offered for the PET, KIM-1 and SYM-1 computers.

Micro Technology Unlimited, PO Box 4596, Manchester NH 03108. Reader Service number 476.

## Apple Carrying Case

A rugged, custom-designed Apple computer system carrying case is now available from Computer Textile, Inc., 10960 Wilshire Blvd., Suite 1504, Los Angeles CA 90024.



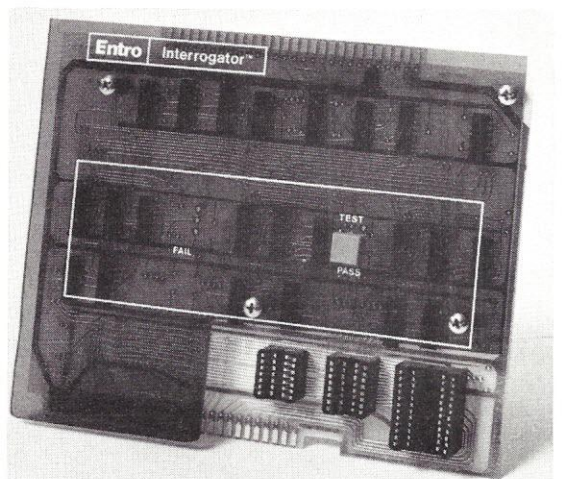
Micro Tech's card file for the AIM-65.

The case contains room for an Apple, 9 inch Sanyo monitor, two disk drives, power strip, two boxes of diskettes and manuals.

The case is finished in black vinyl with metal-reinforced corners. The interior is lined with protective foam rubber covered with black velveteen for a professional appearance. The carrying case includes a built-in shelf over the Apple for the monitor and disk drives so the system may be operated in the case, which measures  $30 \times 21\frac{1}{2} \times 10\frac{3}{4}$  inches and weighs approximately 12 pounds. Price is \$199. Reader Service number 487.

## IC Tester

The 7310 Interrogator tests all standard and custom 5 V digital integrated circuits, 7-segment LEDs and even small circuit boards with up to 24 leads or test points. The unit is driven from a single eight-line output port of a host computer and can exercise and test either individual ICs or groups of ICs in a system under test.



Entro 7310 Interrogator IC Tester.



Individual ICs are tested in the on-board 14-, 16- and 24-leaded ZIF (zero-insertion-force) sockets. Nonstandard sockets and/or worst-case output loads connect through the 26-lead output expansion connector. Active loads on all test pins assure thorough testing of devices with Tri-state or open collector outputs. A separate power bus allows optional manipulation and monitoring of the device under test for special or worst-case conditions.

Test complete and fail test LEDs, as well as start test button on the Interrogator, are ideal for use in production line or incoming inspection modes. The 7310 Interrogator operates

with any computer containing at least 1024 bytes of RAM memory and eight TTL output lines. Price is \$249, including testing manual.

Entro, 1171 Borregas, Sunnyvale CA 94086. Reader Service number 481.

### Switching and Monitoring Units

Giltronix, Inc., 450 San Antonio Ave., Suite 44, Palo Alto CA 94306, introduces a new family of switching and monitoring units for interfacing, configuring and monitoring computers, terminals, printers and modems,

as well as other devices complying with the RS-232 and the IEEE 488 specifications:

- The GRS 232-P24 switches 24 pins. Pin 25 of the 25-pin EIA connector is not switched.
- The GRS 232-S24 switches 24 pins. Pin 1 of the 25-pin EIA connector is not switched but is common to all four EIA connectors.

- The GRS 232-2P24 is similar to the P24 but contains two units in the same housing. It will allow switching of five devices.

- The GRS 232-2S24 is similar to the S24 but contains two units in the same housing.

Each unit consists of a standard three-way switching system and an optional interface monitor. Reader Service number 486.

*Edited by Dennis Brisson*

# NEW SOFTWARE

## Program for Businessmen

How can a computer serve your business? Heath Company, Benton Harbor MI 49022, can help you answer this question with its latest program, "Computer Concepts for Small Business," designed to give the small businessman the information and understanding needed to evaluate how a computer can benefit his business.

The program includes three audio cassettes, which guide the reader through the text material, highlighting important points

and making this program more than just a textbook reading experience. The 160-page illustrated workbook describes the types of memory in a computer, compares the capabilities of different types of storage media and I/Os and discusses the types of software and the tasks they can be designed to perform in a typical small business.

The program also covers the types of personnel needed to run a computer and describes the advantages of time-sharing vs service bureau vs owning. It compares the types of computers and how to select the one that best serves your needs. It even tells you how to select the right dealer to buy your com-

puter from. Price is \$49.95. Reader Service number 479.

## EPROM Programmer Software for PET

Optimal Technology, Inc., Blue Wood 127, Earlysville VA 22936, announces EPROM Programmer software for the PET using OT's Model EP-2A-79 EPROM Programmer. Software, supplied on cassette, includes routines for checking if the EPROM is erased, programming, verifying programming and reading the contents of the EPROM into memory. The programmer connects to the PET via the user I/O port. The program is self-prompting. Software supports the programming of a variety of EPROMs, including the 2708, 2716, TMS 2716, 2732 and the new Motorola 8Kx8 MCM68764 EPROM. Price is \$19.95. Reader Service number 485.

## CP/M BASEX Compiler

BASEX interactive compiler and loader programs include extensions to allow full use of all CP/M operating system facilities and include commands to save and load complete files and list disk directories. BASEX, a new intermediate-level language for microcomputers that combines some of the best features of both BASIC and EXECUTABLE machine-language code, allows you to enter, list, edit and run your program without the help of any auxiliary programs such as editors or linkage editors. Programs run up to 20 times faster than similar BASIC programs. Also,



*Heath's program to evaluate computers in business.*



the BASEX run-time routines are only 2K bytes long, and thus typically require approximately 6K bytes less memory than similar programs that are run with an 8K BASIC interpreter.

Most BASEX commands and features resemble their counterparts in BASIC. In addition, BASEX allows variable names of any length, block memory searches, block memory transfers and named subroutines that can pass multiple arguments to and from the calling program. The \$43 price includes manual, CP/M addendum and 8 inch CP/M disk.

Interactive Microware, Inc., PO Box 771, State College PA 16801. Reader Service number 497.

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## Apple II Time Calculations

Almanac, a new Apple II program with functions related to time, the calendar and general astronomy, should interest those involved in time calculations—general users, businessmen, amateur astronomers, short-wave radio listeners and time travelers. Functions include:

- Calendar calculations that include printing calendar pages for any month specified—even prior to the Gregorian calendar reform—calculation of day of week and day of year for any date and calculation of date of Easter.
- Sidereal time, including a software sidereal clock for calculating star time.
- Sunrise and sunset calculations.
- Calculation of phases of the moon and the dates and times of solar and lunar eclipses.
- Solar system model showing the relative positions of the planets for any date and illustrating the rotation of the planets around the sun, while displaying the time in hundredths of a year.
- A real-time clock that shows the time in time zones around the world.

The program requires at least 32K RAM, Disk II and Applesoft II in ROM. Price is \$29.95 for disk.

Williamsville Publishing Company, PO Box 250, Fredonia NY 14063. Reader Service number 496.

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## Apple II Information System

Infotree is an interactive information storage and retrieval program written in UCSD Pascal for the Apple II. It allows you to store and recall information and organize it in any manner desired. All data stored by Infotree is referenced by a key, a string of up to 18 characters. Up to 18 lines of text can be associated with any key. In addition, any key can own a list of sub-keys, allowing you to separate data into different logical groups to any level desired, as any sub-key can own its own list of sub-keys. Infotree is capable of storing 4380 records on a single diskette.

To run the system press the first letter of the command desired. Infotree fills in the rest and then asks for the key(s) it needs to ex-

cute the command. Pressing → recalls the keys used in the last command one at a time. Infotree also automatically formats the keys as they are typed in. Typical applications include the storage of personal information, mailing lists, phone number directories, appointments scheduling and memos. Price, including user's manual and tutorial, is \$39.95.

Siro-Tech, 6 Main Street, Ogdensburg NY 13669. Reader Service number 482.

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## Statistical Package

Microstat is an advanced statistical package that uses special algorithms designed to minimize errors introduced into many statistical calculations using large numbers. Designed for serious scientific, research and business applications, it utilizes a data management subsystem (DMS) to control, edit and modify all files that are used as data input into the system.

Designed for use on 8-bit computers, Microstat features eight probability distributions, eleven non-parametric tests, chi-square, one- and two-way ANOVA, hypothesis tests (mean and proportions), simple and multiple regression, time series (including exponential smoothing) and data plots. The package is for use with the North Star Disk Operating System and BASIC, one or two drives. Price is \$200; if purchased separately, manual costs \$10.

Ecosoft, PO Box 68602, Indianapolis IN 46260. Reader Service number 484.

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## Data Management System

ICDMS is a new data management system from International Cybernetics, 8 Mary Dr., RR 7, Bloomington IL 61701. This menu-driven program allows you to define up to ten numeric or alphanumeric fields for file records. Record functions include: ADD, CHANGE, DELETE, SORT, SAVE, LOAD and LIST, with many of the functions operating on one, all or a range of records in the file. Field functions allow you to SUM numeric fields or SEARCH for any two to 256 character combinations. In addition, INTELIGENT SUM combines the search and sum functions to sum numeric fields in records meeting search qualifications.

The program is available for the Heath H-89 and Radio Shack TRS-80. Price is \$49. Reader Service number 495.

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## Real Estate Program

Property Analysis System (PAS), for both residential and income property, analyzes the effects of financing, income, expenses, depreciation, taxes and inflation on the return on investment for nine years. PAS produces a three-page analysis consisting of initial condi-

tions and a nine-year projection of property value, liabilities, equity, gross income, expenses, net spendable income and the cash and percentage return on investment before and after taxes. The five-program system written in Micropolis BASIC requires 48K bytes of memory and a CRT with cursor control. It comes initialized for a Hazeltine 1500 CRT and a Centronics 779 printer. Price is \$195.

Investment Analysis Systems, PO Box 282, Palos Verdes Est. CA 90274. Reader Service number 492.

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## More Software

**Series 8000 Medical and Dental Management Systems Upgrade**—from Univair, Inc., 10327 Lambert Intl. Airport, St. Louis MO 63145. New features include optional default of current date for all tickets and reports, carriage-return defaults for all editing functions, patient's name displayed when entering tickets and payments and combined ticket and loading routines. Designed for the TRS-80 Model II and most 32K CP/M disk-based microcomputers. Price is \$495. Reader Service number 488.

**Disk Fix**—a general-purpose disk utility for Mits/Pertec disks that allows any sector of an unmounted diskette to be examined, edited and/or rewritten. Requires 8080 mainframe with 32K, a Mits/Pertec floppy disk drive, CRT and Mits/Pertec disk extended BASIC. Price is \$95. Software Store Ltd., 706 Chipewa Square, Marquette MI 49855. Reader Service number 498.

**Temple of Apsahai**—a solo fantasy adventure game for the Apple that lets the player lead an alter ego on an adventure into a labyrinth of over 200 caverns and chambers, all graphically illustrated in color. The degree of difficulty may be adjusted. Price is \$24.95 for cassette and \$29.95 for disk. Both versions require 48K and Applesoft. Automated Simulations, PO Box 4232, Mountain View CA 94040. Reader Service number 490.

**TRS-80 Business Programs**—Pro Forma (forecasted) Cash-Flow Budget program plans a company's cash needs for up to 12 periods. Price is \$125. Lease vs Purchase program evaluates the benefits of leasing as opposed to purchasing an asset, in light of the newest tax laws. Price is \$100. Management Systems Software, Inc., 5200 Brittany Drive, #1006, St. Petersburg FL 33715. Reader Service number 491.

**Extended Memory Multi-User Software**—EFAMOS is a new multitasking DOS for 8080, 8085 and Z-80 microcomputers that supports multitasking and multi-users with memory mapping. Up to 3 megabytes of memory can be available to users through 32K memory banks. EFAMOS with BASIC compiler, assemblers, utilities and word-processing software is available to OEMs and dealers. MVT Microcomputer System, Inc., 9241 Reseda Boulevard, Suite 203, Northridge CA 91324. Reader Service number 494.



# BOOK REVIEWS

## 6502 Assembly Language Programming

Lance A. Leventhal  
Osborne/McGraw-Hill  
Berkeley CA, 1979  
Softcover, \$9.95

A text on assembly-language programming for microprocessors may address several distinct audiences. Commercial users require training manuals for engineers, both those new to microcomputer design and those seeking an introduction to a new processor. Hobbyists learn assembly language out of curiosity, and to squeeze additional performance from their computers. Personal and business computer owners, using appliance computers, and the growing number of scientists and engineers incorporating personal-type computers into larger systems may be forced to use assembly language to implement functions not provided by the system's designers. The interests and technical background of these groups differ greatly, and are gradually being reflected in the growing supply of textbooks and manuals.

Leventhal's *6502 Assembly Language Programming*, following the format and comprehensive approach of the *Introduction to Microcomputers* series also published by Osborne/McGraw-Hill, succeeds in addressing all these audiences within the space of a single volume. Leventhal adopts a clear, unadorned style that instructs the reader in understanding microprocessor jargon without relying on that jargon. The book avoids excessive abbreviations and acronyms, but the reader will find definitions and examples of their use sufficient to make him comfortable in reading both hobby journals and trade magazines.

This is a large book, almost 600 pages. Extensive sections are printed in boldface letters, clearly and usefully distinguishing basic information from discussion of technical details. The novice may omit lightface sections without losing continuity, while the advanced reader may use these sections as a key, skipping material with which he is already familiar. Abundant figures, tables and illustrations amplify and summarize difficult points; Leventhal uses figures for instruction, not decoration, and includes few superfluous figures even though an illustration adorns almost every page of the text.

The coverage of the text is exceptionally complete. The first two chapters discuss the definition of assembly language, problems for which it may be suitable and the syntax of common assemblers. The standard MOS Technology assembler syntax is used throughout the book. Chapter 3 discusses each operation in detail and includes valuable overviews

of the entire instruction set and of the various addressing modes available to the programmer. The use of indirect addressing, often a confusing topic, is succinctly discussed. Chapter 3 alone is over 100 pages, but prudent pagination and bold page headings simplify rapid location of individual discussions for later reference.

Succeeding chapters treat specific programming techniques and program structures. Loops, string handling, arithmetic routines and the use of tables and list structures are among the topics receiving special consideration. Each chapter includes several specific examples, tested by the author, and concludes with problems extending the worked examples. These problems are suitable for classroom instruction or for independent work and might make the book especially attractive to teachers. Flowcharts, listings and sample data are provided for each example, and the additional references cited in these chapters form a convenient introduction to the literature through mid-1979.

Chapter 11 extends the discussion to input and output devices. Again, the discussion exceeds 100 pages and includes numerous examples. Simple but useful devices, including LEDs, 7-segment displays and keyboards, form a foundation, and Leventhal considers their use at great length. The important LSI support devices commonly used with 6502 microprocessors, including parallel, serial and multiple function devices, are discussed at length. The emphasis throughout is on software aspects of system design; hardware discussion is kept to a minimum.

The concluding chapters treat the important questions of program design and organization with sophistication. Leventhal includes an excellent discussion of the advantages and the costs of modular and structured program design, and of top-down development procedures. His treatment of documentations sets a standard which (unfortunately) few manufacturers match, but which should permit programs to be used and effectively maintained for years to come. In a concluding chapter Leventhal illustrates this design regimen by discussing two moderately complex projects, implementing a digital stopwatch and a thermometer.

Despite its dimensions, *6502 Assembly Language Programming* suffers from some omissions. There is almost no discussion of the applicability of the 6502 to various tasks, or comparison of this processor with other available processors. The 6502 appears to be especially well suited for certain tasks, as witnessed by the greater speed of most 6502 BASIC interpreters compared with, say, their 8080 rivals; when may the designer expect to take advantage of this speed? Similarly, Leventhal provides little guidance to the designer who doubts the feasi-

bility of using a 6502 in his design; although the discussions of program redesign to conserve time and memory are excellent, little is done to prevent the costly attempt to implement possibly high-speed or complex algorithms.

Finally, Leventhal's attempt to rigorously separate hardware from software strikes this reviewer as inherently artificial, even though excellent discussions of hardware considerations are available elsewhere. Placing small or moderate amounts of logic in hardware or software often has a great impact on the design of software systems; programmers should be encouraged to consider implementing functions in hardware as well as to take logical functions over into the program. Although this is not very relevant to the personal computer/business computer audience, the commercial designer should know when to ask his engineering staff to modify the hardware design, if possible, in order to make his own task simpler and more reliable.

*6502 Assembly Language Programming* is relatively free from typographical errors. It does not expect extensive technical background on the part of its readers, although the novice might be advised to follow the author's advice and obtain a copy of the first volume of Adam Osborne's *An Introduction to Microprocessors* (Osborne/McGraw-Hill, Berkeley CA). Few programmers and system designers will fail to find new and useful information in this book; many will find it a useful permanent reference.

Mark Bernstein  
Cambridge MA

## 8080/8085 Software Design—Book 2

Titus, Larsen, Titus  
Howard W. Sams & Co., Inc.  
Indianapolis IN  
Softcover, 348 pp., \$9.95

Having read and learned a great deal from *8080/8085 Software Design* (see *Microcomputing*, September 1979, p. 12), I was pleased to see that it was only an introduction to software design for the 8080 and the 8085. In the preface to *8080/8085 Software Design—Book 2*, the authors state that, while not required, the first volume is an excellent reference for the second volume. I urge purchasing the books as a set. The second volume makes numerous references to the first.

With the multitude of high-level languages available to the microcomputer user, why should you buy a book written at assembly-language level? The main theme of the two books, especially the second, is software design. Chapters 4 through 10 qualify the book as a computer-science source book. Should you de-



# Now! North Star Application Software!

North Star now offers application software for use on the HORIZON! Now you have one reliable source for both hardware and software needs! The first packages available are:

## **NorthWord—**

NorthWord is a simple-to-operate word processing system designed for use with the popular North Star HORIZON. NorthWord enables you to increase office efficiency and cut document typing time and cost. NorthWord incorporates the most sought-after word processing features: easy editing, on-screen text formatting, simultaneous document printing, and much more. NorthWord can be integrated with other North Star software packages to produce customized letters, labels and reports quickly and efficiently.

## **MailManager—**

MailManager enables you to compile and maintain complete organized mailing lists. Lists are easily accessible and can be compiled with a great deal of flexibility. Entries, corrections and deletions are easily made. The North Star MailManager can print your list on individual envelopes, on mailing labels, or in compact summary form.

## **InfoManager—**

InfoManager is a powerful list-oriented, data management system. It will accept up to 50 categories of information for each record and has the ability to select and sort before printing. The North Star InfoManager has power and flexibility for many applications: product inquiry, inventory, customer/client records, calendar reminders, and as an easy way to fill in often-used forms.

## **GeneralLedger—**

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sire to write your own I/O drivers, interrupt service routines, system monitor or debuggers, you can do so with the information from chapters 1 through 3.

Chapter 1 deals with serial communications, both hardware- and software-based. A discussion of serial data formats precedes the hardware discussion, which centers around two serial communication devices: the universal asynchronous receiver/transmitter (UART) and the universal synchronous/asynchronous receiver/transmitter (USART).

Chapter 2 covers interrupts—what they are, the different types, how to use them, how to prioritize them and why to avoid them. For the intrepid user of interrupts, chapter 3 gives both software and hardware applications.

Chapter 4 has a concise discussion of data structures, which any programmer who wants to do data manipulation should read. This chapter is the first of four that deal with data structures and how they are accessed.

Chapter 5 expands upon the theory of chapter 4 by illustrating search subroutines with numerous examples. Chapter 6 deals with sorting numeric values and alphanumeric strings. Two methods are used: the straight insertion sort and the exchange (bubble) sort. Look-up tables are the subject of chapter 7.

Chapter 8 by itself is worth the purchase price of the book. It deals with command decoders for both fixed-length and variable-length commands. Copy the variable-length command decoder for your system monitor, and you won't have to worry about writing another command-decoder program.

System monitors are covered in chapter 9, and the last chapter covers breakpoints and debuggers.

Two appendices are included. Appendix A is a reprint of the Mostek MK5009P data sheet, and appendix B contains some final thoughts on microcomputer interfacing.

Some final thoughts on the book. In the preface, the authors stated that a goal of the book

was to provide detailed descriptions of how the programs work. In my opinion, they succeeded very well—the book could be considered either a computer-science book for programmers interested in the theory of data structures or an assembly-language programming book for 8080/8085 programmers who want to copy programs from the book and have them work. Every program I have used from either book has worked perfectly (hand-assembly errors aside). I recommend that all 8080/8085 programmers buy the book. I make the same recommendation to programmers using other microprocessors who desire a better understanding of data manipulation. You will be able to understand how the programs operate even without a detailed knowledge of the 8080 instruction set.

**J. C. Hassall  
Blacksburg VA**

### On Line

D. H. Beetle, Publisher  
24695 Santa Cruz Hwy., Los Gatos CA

Touted as the "only nationwide classified advertising newsletter devoted entirely to the computer hobby," *On Line* is an unusual publication. Published 17.3925 times per year (every third Friday), *On Line* is a 40-page "buy and sell forum for the computer hobbyist" that is into its fourth year of life. Printed in a 6 × 9 inch pulp format, *On Line* contains individual and commercial advertisements, mostly full width, right-justified and easy to read. There is also some display-ad material from major national vendors (Lifeboat Associates, Percom, Electrolabs, Electronic Systems).

One of the features that makes *On Line* unusual is its advertisements. You'll find unexpected items: an index to computer magazine articles, speedy but reasonably priced PROM

programming, lots of special-interest newsletters, programs seldom, if ever, seen before, microcomputing books, how to "take full advantage of your phone line," hobbyist sources for continuous forms and other supplies, swap-meet announcements and a computer-assisted Bible-study course.

Other distinguishing *On Line* features are in policy and format. At the policy level, the publisher distinguishes between commercial and hobbyist advertisements: a hobbyist ad for one issue costs \$1.50 per 80-character line, and a commercial ad costs \$3.50 per line. These rates are for subscribers (nonsubscribers pay a buck more per line) and go down if your ad runs in more than one issue.

*On Line* provides free advertising space to "people offering useful information/fixes/programs/reference lists or cards available free or for \$1 or less" and to "people offering to serve as a focus for local club or nonbusiness-related users group ads announcing meetings/nonprofit events."

A full page is devoted to computer club meeting schedules—probably the most readable (but not complete) listing available. About 100 clubs are listed. Format features include each page vertically indexed by ad number and horizontally indexed by column number (1–80) plus page number, date, volume and issue numbers. Each issue gives a schedule of upcoming issues with "ads due by" and when they will appear.

A few shortcomings exist. The advertisements are not classified (the publisher does indicate this will be rectified). A few advertisements are so brief that they're hard to understand. For the most part though, *On Line* is a publication that seeks to promote the hobby computer world. It is even priced for hobbyists: four issues cost \$1, 18 issues are \$3.75 and 36 issues are \$7, all mailed first class.

**Douglas Haden  
Socorro NM**

## COMPUTER CLINIC

I am an Englishman living in Argentina. I own an Apple II System (48K, two floppy-disk units). If anyone would like to correspond, I would be pleased (sort of an "Apple out on a limb!").

**P. V. Korrison  
Murature 228  
Punta Alta 8109  
Republica Argentina**

A project of mine requires a special display, one that probably does *not* exist.

Can anyone recommend some companies that might be able to make one for me? I need 360 evenly spaced, independently selectable

LEDs arranged in a circle not larger than three inches in diameter, and since only one light will be on at any time, TTL logic will be used to drive the thing. My breadboarding has reached, what seems to be, a permanent "wait state."

**Joseph A. Lindo  
Box 1714  
APO New York 09109**

We had a small house fire. Destroyed were the schematics for a Wave Mate III Z-80 microcomputer system. In writing Wave Mate, I found they had gone out of business. Does anyone know where I might purchase a set of schematics? Where do you get software for a

system that is no longer manufactured?

**G. Johnson  
Winhall Craft Distributor  
PO Box 9-A  
Bondville VT 05340**

I am restoring a Raytheon 703 minicomputer to use as my personal computer for engineering design and simulation studies. I am looking for readers who are current users or knowledgeable about the machine and will share information.

**Rudolf F. Wrobel  
12725 West 55th Terrace  
Shawnee KS 66216**



# LETTERS TO THE EDITOR

## Praise

It is rare for me to write to a magazine with either praise or complaint, but I am long overdue. I have the complete run of *Kilobaud/Microcomputing*, and I receive *Byte*, *Interface Age* and *68 Micro*.

I must praise the articles by Peter Stark. They are the best things I have seen in any of the magazines to date. I am one of those "computer experimenters" who are becoming less and less heard from. My system is an SWTP 6800/2 with 20K, Percom disk, CT-64 and printer. Peter's articles have been the biggest help I have received, starting with *Kilobaud Klassroom* and now his SWTP system notes . . . great! It is rare to find an author who is easy to read and has such a good grasp of his material. He has saved me from some dead ends and costly mistakes. I have recently renewed my subscription. One reason is Peter's articles; the other reason is your treatment of the 6800. You publish the best journal for us small-systems people.

Dennis Doonan  
Racine WI

## CP/M and You, and You, and You . . .

*Because of the volume of mail, both pro and con, author Thom Hogan received on "CP/M and You" (February 1980, p. 183), he has written this all-inclusive reply.—Editors.*

Many computer users felt strongly enough about my article, "CP/M and You," to write me or *Microcomputing* about it. Half of you wrote to express your thanks for the article, while the other half wrote strongly degrading both my writing and my opinions about CP/M.

I have yet to meet the person who has picked up the CP/M manuals and figured out the system in one reading. I was not even close. For those of you who question my motivation and my knowledge: I work full time managing one of the Midwest's most successful computer stores. My motivation for writing the article was to put to rest the notion that computer users will tolerate sloppy or unintelligible documentation or mental gymnastics necessary for use of software. CP/M is indeed the best operating system currently available for most computers. At the same time, I have had to teach well over 100 customers how to use it. Does that make any sense?

*Why should you have everything provided by Digital Research on your diskette?* Because most users can't get the programs off. I know that sounds facetious, but it is mostly true. I

have actually seen people hand a "non-computer type" a CP/M diskette and a set of manuals and laugh. Seventy percent of the sales at our store are business systems. Ninety percent of those sales are for systems that use CP/M or a derivative. After fighting it, we finally gave up. Now we spend upwards of one man-week carefully creating all of the diskettes any business will need. The first thing we do is erase the unnecessary programs.

Program developers need to have all the utility programs available on-line. I don't know if you have noticed, but diskette wear increases with handling—and I generally have about six hours of programming a day to look forward to. I also will not tolerate a system that requires a ten-page listing just to find which diskette has the utility I'm looking for.

*Using CP/M with one disk drive.* I don't know why so many of you picked up on this point that I made in the article. I've come to the conclusion that one disk drive is not feasible under *any* operating system I have yet to see. I know you can use DDT to copy a program from one diskette to another using a single-drive CP/M system. This is not explained in the manuals, and I point that out on the second page of the article.

*Why do I harp about I/O drivers when they come configured?* They don't always come configured the way you want them. I wrote the article over a year ago, and a lot has changed since then. However, those of you who have bought Electric Pencil and a Diablo printer know that you can't run EP right away. You must change the I/O drivers to look for the Diablo's keyboard, even if it doesn't have one! That's why I made a point about I/O drivers.

My bottom line still stands. In fact, if anything, I now stand by it even more strongly:

- You must have two drives to use CP/M or any other DOS effectively.

- 48K is a necessity. For those of you who took me to task about this, take a look at the list of software you suggested as being available for use on CP/M: Structured Systems Group (requires 48K, two drives), Serendipity (requires 48K, two drives for large data files), Wordstar (strongly suggests 48K, two drives). The Pascals that are available generally take 56K. If you wish to use Digital Research's fine DESPOOL for simultaneous print, you'd better have some extra free space, also.

- You need at least 1/2 megabyte of disk storage.

- Expect to be confused. Digital Research wrote the manuals for system developers, not end-users. I'm in the process of writing a small booklet, which we will provide all users of our CP/M-based software and which we will provide with CP/M-equipped hardware.

- If the software you need isn't available under CP/M, don't expect it to be here tomorrow. Too many people are buying CP/M just to be "software compatible" and not because they need it. I currently have the capabilities of transferring *any* ASCII stream from one of the machines we sell to any other, and I don't need a software bus in that case.

If anyone has differing viewpoints on CP/M, I'd love to hear them. I like CP/M as an operating system. I dislike people buying things they don't need or won't figure out how to use. As a computer-store manager, I enjoy the challenge of trying to find the right equipment for the right customer.

Thom Hogan  
Basically Speaking  
719 Anna Lee Lane  
Bloomington IN 47401

## "NAVPROG" Right Up There

Congratulations to Leland Young for his article, "NAVPROG," in the February 1980 issue. In converting the program for use on my TRS-80, I have discovered one bug. Under certain conditions, the flight plan will give an incorrect magnetic heading (MH). We don't want any pilots getting lost! (See Example 1.)

As a commercial pilot with a major U.S. airline, I find that "NAVPROG" provides an insight into how our airline's computerized flight plans must be derived.

Paul Sturpe  
First Officer, USAIR  
Coraopolis PA

## Elegant Elf EPROMmer

Many thanks for the article by Robert Cotter in the February 1980 issue describing an elegant 2708 programmer for the Elf II ("The Elf EPROMmer"). We built one on a 4 by 4 1/2 inch card that plugs into the 44-pin connector on a

Change Line 1600 to read: IF X>180 THEN X2=X:X=360-X  
Change Line 1660 to read: IF X2>180 THEN Q(I)=W4+X1:GOTO 1680

Example 1.



Super Elf board. The Super Elf 4K expansion board contains an output port that we attached to the EPROM board with a 16-pin DIP connector.

Instead of the 67 instructions required by Elf II, the Super Elf output port uses 63 instructions, and this substitution should be made in the program. We chose to input the N0 and N1 lines to an unused gate on the 7400, invert the output with 1/6th of the 7406 (a pull-up resistor is required) and substitute the resulting signal for N2. However, it should be sufficient to substitute N1 for the N2 shown in Fig. 1 of the article.

Fig. 1 contains a typographical error. The A9 input pin on the EPROM socket is incorrectly marked 24; it should be 22.

David Moews, Paul Moews  
Storrs CT

## DD\*

Please consider yourselves to have been flogged with a wet towel. For shame! Your use of the phrase "Due to a computer error . . ." on page 18 of the February 1980 issue of a magazine widely read in the computer industry addresses your audience in a recognizable fashion . . . somewhat like waving a reg flag in front of a bull.

*\*Pair o' Ds. We were just poking a little ironic fun at the "wave the reg flag at the bull" approach. Concerning the towel-flogging, we're a little worried . . . we liked it.—Editors.*

## Challenging the Thought Processes

The OSI Challenger II article by Richard Lary in the February 1980 issue of *Microcomputing* started me thinking about a problem I gave up on several times. The code given by Lary for quick screen clear has appeared in several publications, but the article stated that the routine was in ROM and could be located anywhere in memory without change. Nobody told me that before!

I finally located the code starting at 65036 and ending at 65061 (it had two extra bytes for some reason). I have never been able to add two numbers in machine language, but I was able to devise a way to transfer the existing routine to RAM, add the RTS and do the other necessary POKES to make it go. The basic code is shown in Example 2. Line two PEEKs at one byte of ROM, calls it "y" and POKES it back into RAM at a fixed distance (60967 bytes) away.

The advantage is a saving of memory space

```
30000 POKE 133,228; POKE 134,15; POKE 11,229;
      POKE 12,15; POKE 4095,96
30010 FOR M = 65036 TO 65061: Y = PEEK(M); POKE
      M - 60967,Y; NEXT
```

Example 2.

and typing because ROM instead of DATA is read. Programs that use a lot of scrolling to clear the screen can wind up with an overall saving in memory. I'm memory conscious because I haven't expanded from the original 4K . . . actually 3327 usable bytes.

OSI makes a fantastic machine, but documentation is nil. A book could be published about the goodies people have found by accident. Also, if anyone could figure out how to use the existing polled keyboard routine (with changes) to read the keyboard *without stopping* if no key were down, I could proceed with my long-desired CW sending program.

Robert D. Garrett  
Decatur AL

## Necessary Evil

Allan Flippin's article in the March issue on assembly-language benchmarks was super. I appreciate the enormous effort that went into it. I must, however, contest, or at least qualify, some of his observations and conclusions.

For lack of a better method, benchmarking may be a necessary evil in rating processors. However, the real proof is performance in a real application where program length is on the order of 1K or more. In a real application, most of the processors tested will be hard-pressed to equal the memory utilization of either the 6502 or 1802, even though in the benchmarks they are rated only seven and eight. Since the architecture and instruction sets of both of these, particularly the 1802, depart significantly from

the 8080 norm, even the most ardent aficionados often grossly underutilize their power.

Although Mr. Flippin allows the 9900 to have registers in memory space, he doesn't mention that with its indirect addressing capability the 6502 effectively has up to 128 pairs of registers in memory that can be used as address pointers. The 8080 has the lone HL register, which becomes a serious bottleneck. Although 8080 memory reference instructions are only one byte long, the load-immediate takes three bytes, resulting in a total of four bytes. The 6502's memory references require two-byte instructions, but these register pointers can be table-loaded into zero page, with negligible load overhead, and left there indefinitely.

In short, the 6502 and 1802 do much better in memory utilization in real applications than the benchmarks indicate because both take advantage of clever programming techniques unique to their architecture which don't come into use in benchmark-level programs.

By knowing and understanding your processor's architecture and instruction set, and applying techniques to take advantage of its strong points, you can expect performance better than indicated by the benchmarks in real world applications.

Gene Zumchak  
Buffalo NY

**Please type all letters to the editor in uppercase and lowercase letters, and double-space the typing. Thank you.**

## PET-POURRI

(from page 8)

Since this volume was written for the older 8K PET, the errata sheet is extensive because of the original problems with data file handling. The newer models and those with the ROM upgrades no longer have to turn on the cassette motor to manually create wider gaps between tape records. The operating system has been corrected to automatically fix this annoying problem. However, this volume should be valuable in understanding the use and implementation of data files under program control.

*Workbook 5—PET Miscellaneous* covers unrelated features and functions not covered in the other volumes. The errata sheet for this volume does not give the new values for the material on pages 5-4 to 5-9. The primary floating-point accumulator is now located at locations 94 to 99 (decimal).

*Workbook 6—PET Control and Logic Statements* describes testing and branching, subroutine use and logic operations. It provides more overall information on how to write a BASIC program.

Please address all correspondence directly to Robert Baker, 15 Windsor Drive, Atco NJ 08004.

## CONTEST

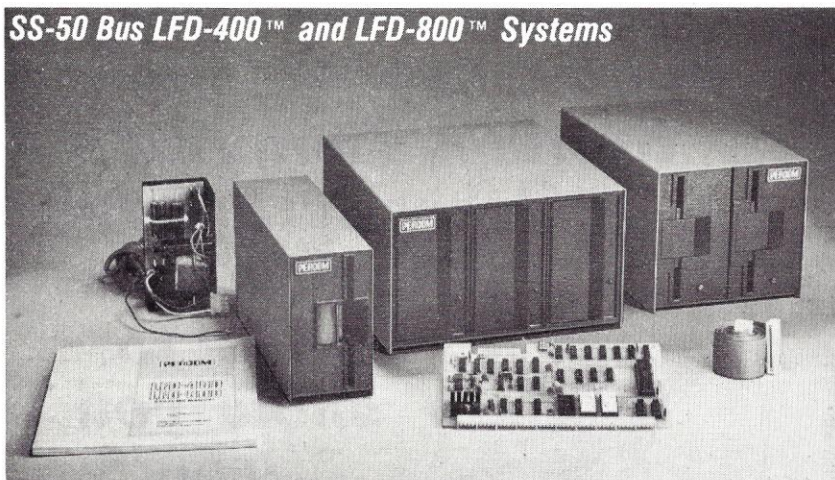
The winner of the \$500 prize in our "best article of the year" contest is R. M. Law and D. C. Mitchell's "A Text Formatter in BASIC" from the May 1979 issue. Many thanks to all who voted. Our regular "best article of the month" contest has been discontinued. Perhaps we'll do it again in the future. Congratulations to R. M. and D. C.!





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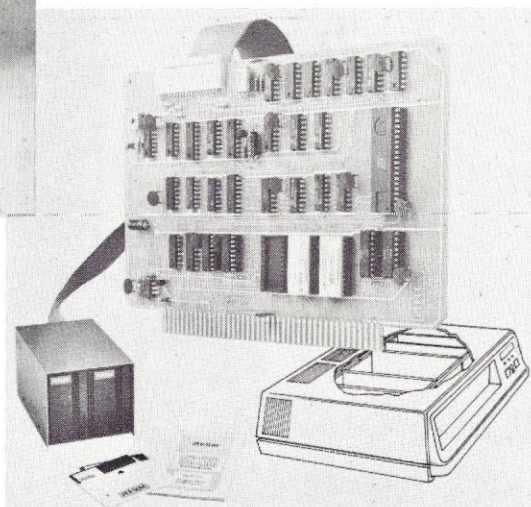
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EXORciser\* Bus LFD-400EX™ -800EX™ Systems

✓ 14

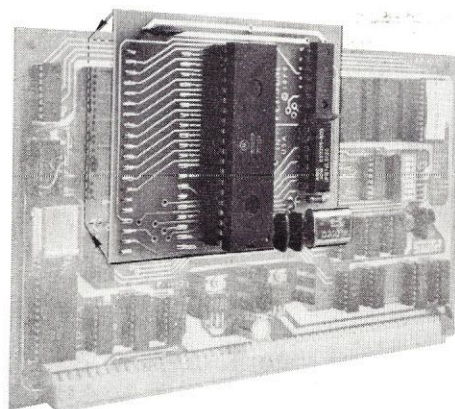
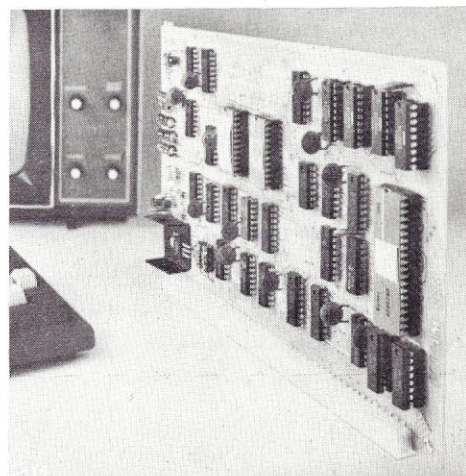
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## Upgrade to 6809 Computing Power

This 6809 upgrade adapter may be used on the SWTP 6800 and most other 6800/6802 MPU cards. Supplied assembled and tested, it costs only \$69.95 with user instructions. The original system may be restored by merely unplugging the adapter and a wire-jumpered DIP header, and re-inserting the original components. Also available for your upgrade computer is PSYMON™, the Percom SYstem MONitor for the Percom 6809 single-board computer. PSYMON™ on 2716 ROM costs only \$69.95 — PSYMON™ is also available on minidiskette, with source and object files, from the Percom Users Group.

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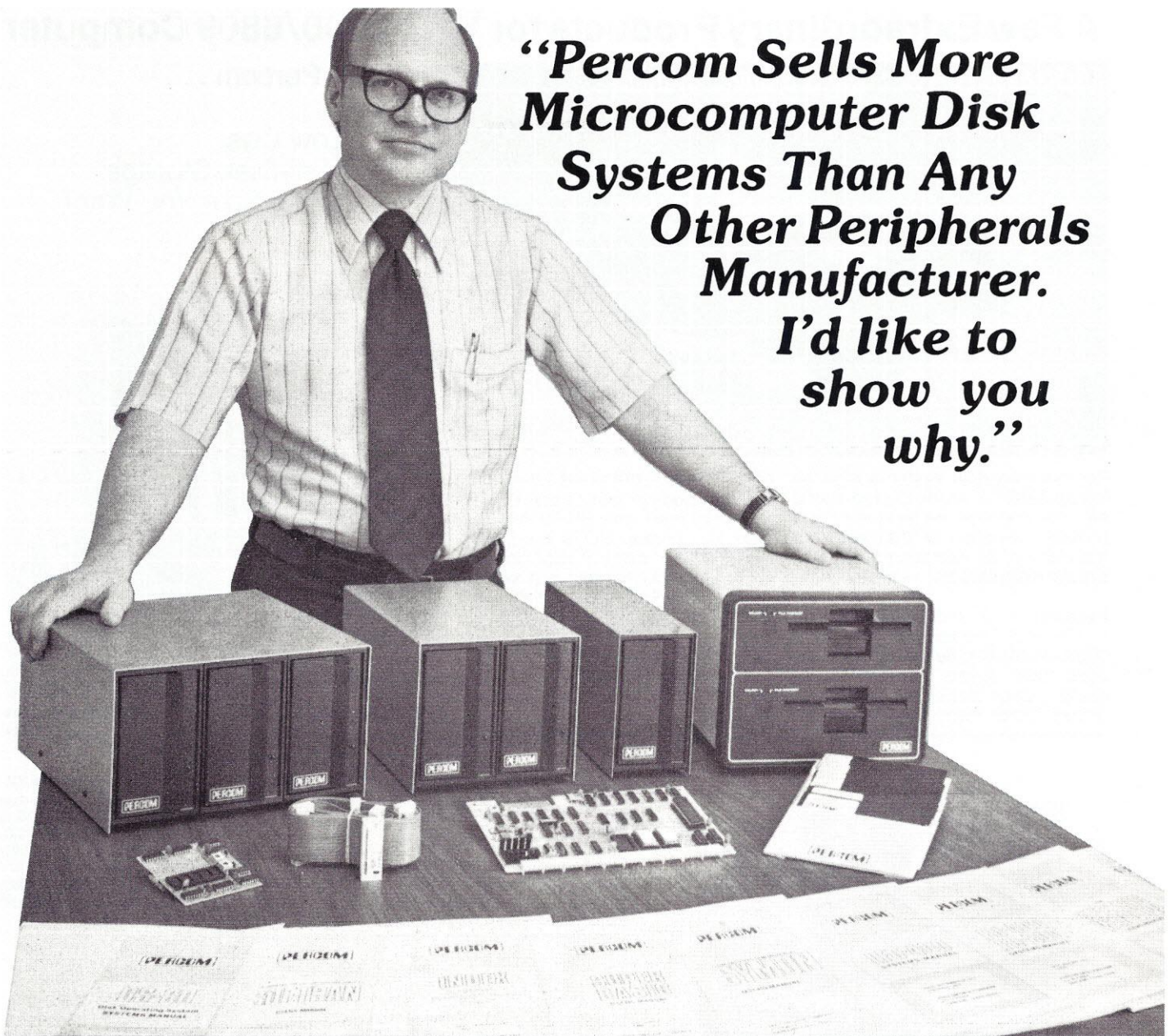
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President, Percom Data Company*

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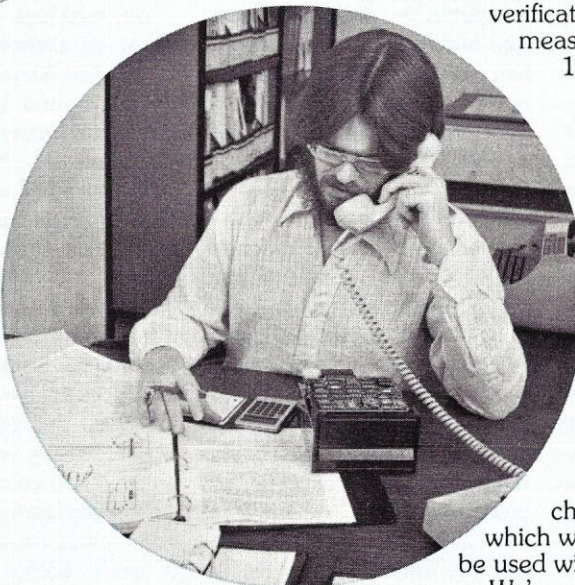


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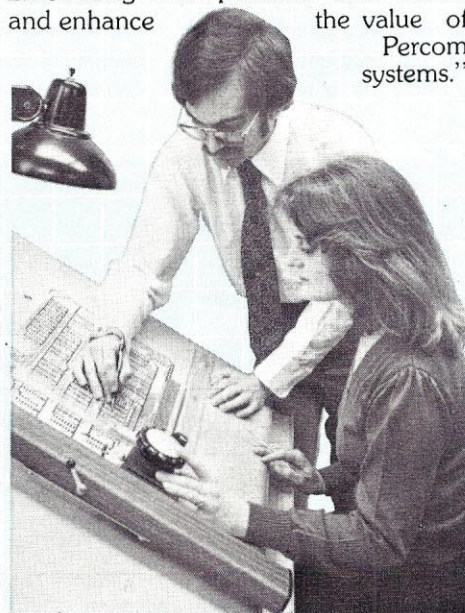


"Richard's making final changes to a disk controller which will allow Percom drives to be used with yet another computer."

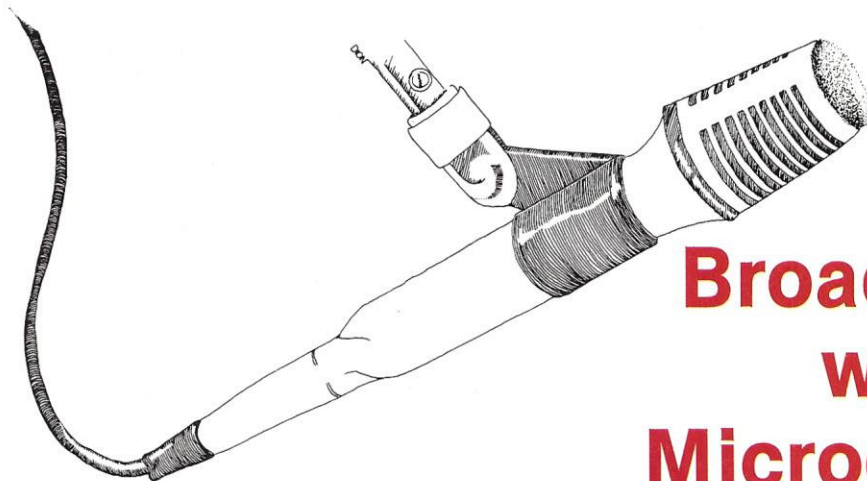
We're constantly developing and introducing new products that extend and enhance the value of Percom systems."



"Slipping a circuit board through the eye of a needle would be easier than slipping a cold solder joint past Beverly. These are four-drive LFD-400/800 disk system controllers she's inspecting."







# Broadcasting with a Microcomputer

---

*The folks at WKYB decided to computerize their program log with a TRS-80.*

---

Don Hastings  
Box 366  
Hemingway SC 29554

I had just invited the computer salesman out of my office never to return until he agreed to speak English, my kind! I felt a computer was what we needed at the radio station, but how was I to select one (and a program) when these guys all insisted on talking RAMs, ROMs, bits, bytes and bauds! Twenty to forty thousand dollars was simply too much money to play around with on something we were not certain would do the job for us. Obviously, if I were to make an intelligent choice, I had to have some idea of just what I was buying. Then I noticed the Radio Shack TRS-80.

We bought it just for our own education and to get some idea

of what was involved in using a computer. We knew it was limited but felt it at least would help us understand the basics. Maybe we would even be able to communicate with computer salesmen!

## Getting Hooked

The TRS-80 instruction manual is a jewel. With only the ability to read and minimal patience, anyone should be able to operate this computer using that instruction manual. It held our attention better than a best-seller for three days. Best of all, it gave us confidence in approaching that keyboard. The exercises were downright fun, and the author's invitation to modify them on our own was a challenge we could not resist. We wondered why it had all seemed so complicated before. There just isn't anything like

hands-on experience.

We watched cannon balls shoot off castles, Snoopy yell at the Red Baron (courtesy of *Kilobaud*) and the computer guess any number we picked. We wrote all the cute little games all other beginners probably do and learned how to compress, abbreviate and cheat.

OK, we became hooked on microcomputers. Even the secretaries were wagering at Blackjack! The mystique of the computer had been lifted and we felt there was little that smart micro couldn't do. Then we learned the limit of 4K memory. We had never experienced a "sorry" before and stared in disbelief at that soon-to-be-hated notation. The prescribed cure was 16K, the limit of the TRS-80 in Level I.

## Programming the Program Log

With 16K, the world suddenly seemed enormous, and we began considering actually doing a broadcast log on the little giant. A broadcast log is the heart of all daily broadcast operations. It contains every program, newscast, public service announcement and commercial to be aired each day. It must meet strict FCC regulations and thus is prepared with great care. It is called the program log, and just like a computer program, it establishes the order of events for things to happen.

To make a program log, the

computer must be able to understand where each item on the log is to go and be able to remember all the information about each commercial account—account number, product code, commercial length, number to be aired that day, what times they can be aired and what priority each account has in choice of air-time. Then the computer must schedule each account only in those spaces allotted for commercials, which means it must remember where these positions are located, what is allowed in each, how much time is available in each position and if a competing account is already occupying part of that space.

Suddenly, 16K and only one array didn't seem like very much. We considered reconsidering. There were so many little decisions we had always taken for granted. The prospect of programming a computer to do it all seemed overwhelming. In short, we panicked.

Then, something from the instruction manual gave us hope... the use of subroutines. All those little decisions could be programmed using subroutines! Now, I know most experienced programmers would say, "Dummy, of course you use subroutines." But for us beginners the use of subroutines helped us to see the light at the end of the tunnel.

Subroutines automatically meant we had to break the job down into smaller parts and



*Hard at it viewing a completed log.*



tackle each one individually. We no longer were fighting the enormous job of a complete program log, but only a small part of it at a time. Without a doubt, the use of subroutines is what made this job possible in only 16K of memory. Also without a doubt, being able to tackle the overall program in small pieces saved our sanity.

The next best piece of advice the manual gave us was to leave open lines for later additions. Since we were inexperienced, we began leaving 20 lines between statements and 1000 between separate elements of the program. What a blessing that turned out to be!

We wrote our programs on notebook paper before entering them into the computer, but our inexperience showed up quickly when whole routines began crashing because of wrong procedures. Until we learned better, we found it easier to write directly into the computer and run samples as often as possible. Again, there is nothing like hands-on experience to find out what won't work.

We quickly learned to write the display routines first. Not only did it solidify exactly what previous routines must accomplish, it also provided us with a quick visual check of how we were doing. We spotted many errors early because we had the routines written to display the results.

It took us three months, working nights and weekends, to complete the first working program. We fit it into that little Level I 16K TRS-80, which cost less than \$1000. It saved the company thousands of dollars by cutting almost in half the time it now takes to do a broadcast log. As an added plus, it provided us with a log that is more consistent day to day since it makes decisions exactly as directed without errors produced by colds, flu, loss of sleep or other foibles in the human makeup. We gained an experience with computers that will be most helpful in making an intelligent decision on future computer needs. There's no doubt that our experiment with a microcomputer has been

a success.

We have used the TRS-80 at this station since July 1978 and added a little more to our program, compressed a little more and, with our growth in experience, now have a versatile program doing almost twice as much as the original. Naturally, with Level I and only 16K, there are some limitations.

### The Program

In order to obtain a printout, the program listing is a Level II conversion. Originally, for this program to run in 16K, we had to take advantage of every abbreviation allowed in Level I. With the refinements we have added, this factor is not as critical.

Lines 100 to 180 set to zero all arrays that comprise the broadcast day as entered in Line 110. Since we are a day-timer (operating from sunrise to sunset) our broadcast day will vary from month to month. We did not use military time because most of our operators were unfamiliar with it, and we decided facing a computer (even a micro) for the first time was trauma enough. There is no such compromise in the new Level II program being completed.

Since we operate on a clear channel, we not only must leave the air between local sunset and sunrise to make way for the clear-channel station, we must also operate at half power in the early morning and evening. Lines 200 and 210 place a special tape to play at the time of power changeover to provide low-level modulation for the change.

We have each hour divided into a maximum of twelve commercial "breaks" with no more than four events to be scheduled in any one break. Thus, each hour has the capability of 48 scheduled events. We spread the twelve breaks evenly around the hour, one every five minutes. It is seldom we use all of these positions, but it provides the capability of placing an event almost precisely when we would like it to air. (See Fig. 1.)

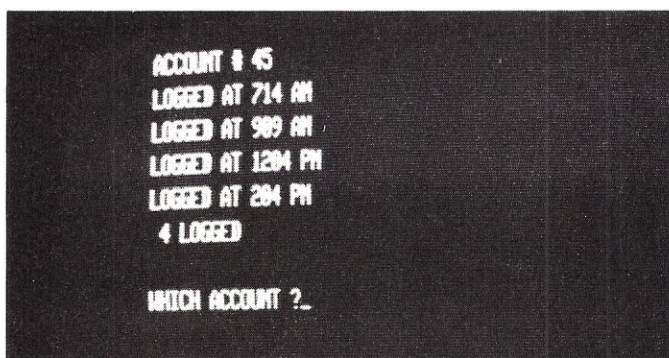
Lines 300 to 370 automatically enter our newscasts into the log positions they will occupy based upon the spread of those

positions as described above. Thus, the first newscast position is set at 633 (6 AM, position 33), and we move through the log each hour from there.

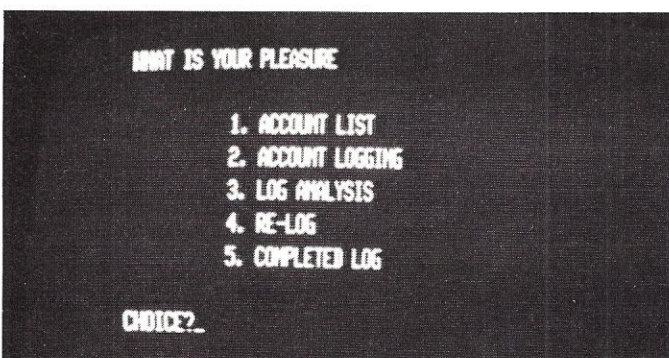
Lines 400 to 440 allow us to set aside any portion of an hour or the entire hour for special programs. These might be religious, public affairs, etc., where

either no commercial matter is to be allowed or the program has been sold to specific sponsors and the computer is being told to keep its cotton-picking hands off that time!

Lines 600 to 680 schedule special announcement and jingle tapes, which play during periods when we are completely



The computer displays the spread of an individual account.



Selection of displays and additional routines after completing a log.

| HOUR       | MINUTES | HOUR | MINUTES |
|------------|---------|------|---------|
| 500        | 0       | 1500 | 13.5    |
| 600        | 14      | 1600 | 14      |
| 700        | 14.5    | 1700 | 14      |
| 800        | 15      | 1800 | 0       |
| 900        | 13.5    | 1900 | 0       |
| 1000       | 11      | 2000 | 0       |
| 1100       | 10.5    | 2100 | 0       |
| 1200       | 12.5    | 2200 | 0       |
| 1300       | 11      | 2300 | 0       |
| 1400       | 12      | 2400 | 0       |
| CONTINUE?_ |         |      |         |

Commercial minutes logged each hour in a completed log.



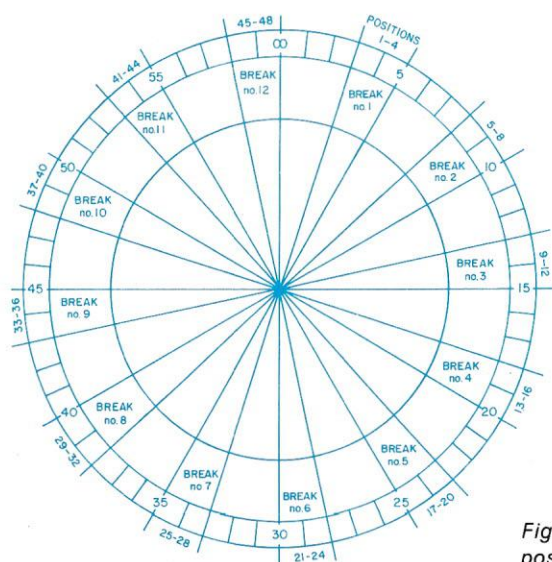


Fig. 1. Provision for 12 "breaks" per hour, four positions per break.

automated on the air. Lines 800 to 900 add weather and headline sponsors to the log, and add their commercial time to the totals for each hour.

Lines 1000 to 1220 provide the capability of logging an event either at a precise time on the log or within a specified time period. This routine even has a nice little display to inform the operator there are no availabilities in the time periods requested. We debated on including that display for fear the

operator would beat the machine to death.

Lines 2000 to 2070 are the entry points for all other accounts not sponsoring special programs or specifying time periods for their commercials. These accounts will be spread throughout the broadcast day.

Lines 3000 to 4360 are the workhorse of the whole program. This routine makes the decisions what to do with all the commercials that have been fed into the computer's general accounts. Things considered during the logging process include the spread of the commercials throughout the day, product

### Program listing.

```

10 REM ** WRITTEN BY DON HASTINGS, 6/78
11 REM ** LAST UPDATE 12/78
20 X=5000
30 A(X)=0: X=X+100: IF X<2100 GOTO30
100 CLS: PRINTTAB(18), "S T O P   T A P E": Y=1: N=0
110 PRINT"SET LOG": GOSUB9000: F=U: G=V: PRINT"CLEARING": X=1
120 FOR L=D TO D+48: A(L)=0: NEXT L: D=D+100: IF D<E GOTO120
150 FOR A=X TO X+94: A(A)=0: NEXT A: X=X+100: IF X<2000 GOTO150
160 FOR H=91 TO 95: A(H+100)=5: NEXT A: A(100)=0: A(200)=0: X=549
170 FOR C=X TO (X+24): A(C)=0: NEXT C
180 X=X+100: IF X<900 GOTO170
200 CLS: PRINT"POWER CHANGE"
210 INPUT"AM ": X: A(X)=95: INPUT"PM ": X: A(X+1200)=95
300 CLS: PRINT"LOGGING NEWS": PRINT: X=633
310 FOR L=X TO (X+7): IF L>7>G GOTO350
320 IF L<F: X=X+100: GOTO310
330 A(L)=100: NEXT L: H=INT(X/100)*100: A(H)=120: IF X<1033 X=X+100: GOTO310
340 X=X+200: GOTO310
350 INPUT"ENTER UNSPONSORED ": L: IF L=0 GOTO410
360 INPUT"AM ": X: IF X=0 L=L+1200
365 M=INT(L/100)*100: A(M)=0
370 L=M+33: A(L)=0: A(L+1)=0: A(L+2)=0: GOTO350
410 CLS: PRINT"PROGRAMS": GOSUB9000: IF U=0 GOTO500
420 FOR L=D TO D+48: IF L=D: A(L)=0: A(L+1)=100
430 NEXT L: D=D+100: IF D<V GOTO420
440 GOTO410
500 A(849)=91: A(850)=92: A(851)=93: A(852)=94: A(649)=95: A(549)=96
610 CLS: PRINT"AUTOMATION": GOSUB9000: IF U=0 GOTO800
620 L=D+8: GOSUB700: L=D+32: GOSUB700
625 L=D+12: GOSUB700: L=D+24: GOSUB700
630 L=D+36: GOSUB700: L=D+40: GOSUB700
640 L=D+20: GOSUB730: L=D+44: GOSUB730
650 L=D+4: GOSUB750: L=D+28: GOSUB750
660 L=D+16: IF (L/100)*(L/100)*A(L)=0: A(L)=92
670 D=D+100: IF L<8<V GOTO620
680 GOTO610
700 IF (L/100)*(L/100)*(A(L+4)<100)*(A(L)=0) A(L)=93
710 RETURN
730 IF (L/100)*(L/100)*(A(L)=0) A(L)=94
740 RETURN
750 IF (L/100)*(L/100)*(A(L)=0) A(L)=91
760 RETURN
800 X=1: A=90: Q=853
810 CLS: PRINT"WEATHER FLIGHT ": X: GOSUB9200: IF A(R)=0 GOTO920
850 ON X GOTO860, 870, 880, 890, 900, 910, 920
860 L=704: T=1300: GOSUB960: GOTO810
870 L=728: T=1300: GOSUB960: GOTO810
880 L=1304: T=1800: GOSUB960: GOTO810
890 L=1328: T=1800: GOSUB960: GOTO940
900 L=716: T=1300: GOSUB960: GOTO940
910 L=1316: T=1800: GOSUB960: GOTO1000
920 X=X+1: IF X<5 GOTO810
930 IF X<6 GOTO1000
940 CLS: PRINT"HEADLINE FLIGHT ": X=4: GOSUB9200: IF A(R)=0 GOTO920
950 GOTO850

```

```

960 IF L<F L=L+100
970 IF (L/100)*(L/100) X=X+1: A(Q)=A: Q=Q+1: A=A+1: RETURN
980 IF A(L)<100 A(L)=A
990 A=INT(L/100)*100: A(M)=A(M)+A(A+100): L=L+100: GOTO960
1000 Q=859
1001 CLS: PRINT"SPECIAL LOGGING": GOSUB9200: IF A(R)=0 GOTO1010
1002 INPUT"HOURLY ": U: INPUT"AM ": X: IF X=0 U=U+1200
1003 INPUT"POSITION ": L: INPUT"CORRECT ": X: IF X=0 GOTO1002
1004 A(U)=A(U)+A(A+100): L=L+U: A(Q)=A: A(L)=A: Q=Q+1: A=A+1: GOTO1001
1010 RESTORE: T=0: CLS: PRINT"SPECIFIED TIMES": PRINT: PRINT"ACCOUNT #": A
1020 INPUT"CODE ... ": A(A): IF A(A)=0 GOTO2010
1030 INPUT"LENGTH ... ": A(A+100): INPUT"SPOTS ... ": A(A+200)
1035 PRINT: INPUT"CORRECT ": X: IF X=0 GOTO1010
1040 X=A(A): GOSUB9300
1050 IF A(Q)<0 Q=Q+1: GOTO1050
1055 A(Q)=A
1060 CLS: PRINT"ACCOUNT #": A: " - SPOTS LEFT ": A(A+200): GOSUB9000
1070 PRINT: INPUT"SPOTS ... ": W: IF W<A(A+200) GOTO1060
1080 READ S: L=S+D+M: T=T+1: IF T=13 GOTO1160
1085 IF L<U L=L+100
1090 IF A(L)<0)*(L/100) L=L+100: GOTO1090
1100 Z=A(A+100): IF L<V GOTO1080
1105 IF M=0 X=A(L+3): Z=Z+A(X+100): IF A(X)=A(A) GOTO1150
1110 IF M<1 X=A(L+2): Z=Z+A(X+100): IF A(X)=A(A) GOTO1150
1115 IF M<2 X=A(L+1): Z=Z+A(X+100): IF A(X)=A(A) GOTO1150
1117 IF M=2 X=A(L-2): Z=Z+A(X+100)
1118 IF M=1 X=A(L-1): Z=Z+A(X+100)
1119 IF Z>92 GOTO1150
1120 C=INT(L/100)*100: A(C)=A(C)+A(A+100)
1125 A(L)=A: M=M-1: A(A+200)=A(A+200)-1: IF A(A+200)=0 GOTO1190
1130 IF W<0 GOTO1150
1140 CLS: RESTORE: T=0: GOTO1060
1150 L=L+100: GOTO1090
1160 PRINT: PRINT"UNABLE TO LOG": W: INPUT"OTHER TIMES AVAILABLE ": X
1180 RESTORE: T=0: IF X=1 GOTO1060
1190 A=A+1: GOTO1010
1200 IF A(X)=A(A) L=L+100: GOTO1090
1210 Z=Z+A(X+100): IF Z>92 L=L+100: GOTO1090
1220 RETURN
2010 CLS: PRINT"GENERAL ACCOUNTS": A=1: PRINT
2020 PRINT"ACCOUNT #": A: GOSUB9400: CLS: IF A(A+300)<0 A=A+1: GOTO2020
2025 B=A: A=1: X=1
2030 CLS: PRINT"VERIFICATION": PRINT
2040 PRINT" #   CODE", "LENGTH", "SPOTS", "PRIORITY"
2050 PRINTA: " ": A(A), A(A+100), A(A+200), A(A+300)
2052 IF A(A)=0 GOTO2060
2055 A=A+1: IF A<X+9 GOTO2050
2060 PRINT: INPUT"CORRECT": Z: IF Z=0 CLS: INPUT"ACCOUNT #": A: GOSUB9400: GOTO2030
2070 X=X+9: IF A(A)<0 GOTO2030
3000 CLS: PRINT"LOADING": A=1: C=1
3010 X=A(A): IF X<C GOTO3100
3020 GOSUB9300: M=A
3030 IF A(M)=0 A(M)=A: GOTO3100
3040 M=M+1: IF M<24 GOTO3030
3050 M=849: Q=M: GOTO3030
3100 A=A+1: IF A<B GOTO3010
3110 H=1: C=C+1: IF C<15 PRINT"CODE": C: GOTO3010

```



separation from competing accounts, maximum time allowed in any one commercial break and maximum commercial time allowed in any one hour.

Finally, we come to the display routines that are selected in lines 5000 to 5080. Because of memory limitations we originally had only the first three displays, but as we learned to condense and improve our program we were able to add three additional display routines. All of these display routines are contained in lines 5090 to 9410 along with the subroutines for account entries and various decision-making elements of

the total program.

### Older and Less Dumb

Currently we are in the process of completing a completely revised program for Level II. When I look back on the amount of memory consumed in our earlier Level I programs and how we have been able to condense them over the months, it is quite evident how quickly anyone can acquire programming knowledge. At least, I like to think of it as symbolic of our growth, but it really shows how dumb we had to be. That means we aren't necessarily more intelligent now, just less dumb. ■

```

4000 CLS: S=0: P=1: I=1
4010 H=0: J=549
4020 PRINT "LOGGING CAROUSEL"; 5+H; " PRIORITY"; P
4030 FORR=J TO J+24: IF R=J+24 GOT04340
4035 RESTORE: T=0: K=0: IF A(R)=0 GOT04335
4040 X=A(R): IF (A(X+200)<1)+(A(X+300)<0)+(X<0) GOT04335
4045 C=A(X+200): C=INT(10/C): IF C<1 C=1
4050 L=INT(F/100)*100: K=K+1: IF K>13 GOT04335
4060 DATA 1, 25, 13, 41, 17, 45, 5, 29, 21, 9, 37, 33, 45
4065 READ V: L=L+V+H: T=T+1: IF T=12 RESTORE: T=0
4070 IF L<F L=L+100: GOT04090
4100 IF L>G GOT04050
4105 IF A(L)<0 L=L+100: GOT04100
4110 Q=0: Z=A(X): IF L>G GOT04050
4115 M=INT(L/100)*100: IF A(M)+A(X+100)>1000 GOT04330
4120 IF A(X+100)=30 GOT04130
4125 IF A(L+4)=100 L=L+100: GOT04100
4130 O=1: IF H=3 GOT04160
4140 U=A(L+0): Q=Q+A(U+100): IF Z=A(U) GOT04330
4150 O=O+1: IF O=H+4 GOT04140
4160 O=1: IF H=0 GOT04190
4170 U=A(L+0): Q=Q+A(U+100): IF Z=A(U) GOT04330
4180 O=O+1: IF H=0=0 GOT04170
4190 IF S=1 GOT04230
4200 IF Q+A(X+100)<15 GOT04330
4210 IF Q+A(X+100)>91 GOT04330
4220 GOT04300
4230 IF Q+A(X+100)>121 GOT04330
4300 A(L)=X: A(X+200)=A(X+200)-1: A(M)=A(M)+A(X+100)
4310 PRINT "ACCOUNT"; X; " AT"; L: IF A(X+200)<0 GOT04335
4320 L=L+(C+100): GOT04100
4335 IF I=0 GOT06300
4336 NEXT R
4340 H=H+1: J=J+100: IF H<4 GOT04020
4350 IF S=0 PRINT "VERIFYING": S=1: GOT04010
4360 IF P<3 S=0: P=P+1: GOT04010
5010 CLS: PRINT "WHAT IS YOUR PLEASURE"
5020 PRINT: PRINT "1. ACCOUNT LIST": PRINT "2. CAROUSEL LOADING"
5030 PRINT "3. COMPLETED LOG": PRINT "4. ACCOUNT LOGGING"
5040 PRINT "5. ATTEMPT RE-LOGGING": PRINT "6. LOG ANALYSIS"
5070 PRINT: INPUT "CHOICE"; X
5080 ON X GOT05200, 8010, 7010, 5090, 6000, 5500
5090 PRINT: INPUT "WHICH ACCOUNT "; X: A=0: IF X=0 GOT05010
5100 CLS: PRINT "ACCOUNT #"; X: T=INT(F/100)*100
5110 FOR Z=1 TO 48: IF A(T+Z)=X W=T+(Z*.85): A#="AM": GOT05140
5120 NEXT Z: T=T+100: IF T<G GOT05110
5130 PRINT: "LOGGED": GOT05090
5140 W=INT(W): IF W>1300 W=W-1200: A#="PM"
5150 PRINT: "LOGGED AT "; W; " "; A#: W=W+1: GOT05120
5200 CLS: PRINT "ACCOUNT CODE LENGTH SPOTS"
5210 FOR H=X TO (X+12): PRINT TAB(3); A: TAB(12); A(R); TAB(21); A(A+100);
5220 PRINT TAB(33); A(A+200): IF A(A)<0 NEXT H
5230 PRINT: INPUT "CONTINUE "; Z: IF (Z=1)*(A(A)<0) X=X+13: GOT05200
5240 GOT05010
5500 CLS: PRINT "HOUR", "MINUTES", "HOUR", "MINUTES"
5510 FOR M=500 TO 1200 STEP 100
5520 PRINT: A(M)/60, M/60, A(M+800)/60: NEXT M

```

|          |          |          |          |
|----------|----------|----------|----------|
| 601 = 1  | 613 = 0  | 625 = 42 | 637 = 0  |
| 602 = 2  | 614 = 0  | 626 = 45 | 638 = 0  |
| 603 = 0  | 615 = 16 | 627 = 49 | 639 = 16 |
| 604 = 0  | 616 = 17 | 628 = 0  | 640 = 50 |
| 605 = 0  | 617 = 21 | 629 = 56 | 641 = 0  |
| 606 = 0  | 618 = 23 | 630 = 65 | 642 = 0  |
| 607 = 9  | 619 = 0  | 631 = 0  | 643 = 0  |
| 608 = 11 | 620 = 0  | 632 = 53 | 644 = 0  |
| 609 = 12 | 621 = 0  | 633 = 0  | 645 = 7  |
| 610 = 14 | 622 = 0  | 634 = 0  | 646 = 0  |
| 611 = 0  | 623 = 28 | 635 = 76 | 647 = 15 |
| 612 = 0  | 624 = 29 | 636 = 88 | 648 = 0  |

CONTINUE ?

6 AM log page with accounts paged. Numbers 601-648 are log positions, not times.

```

5530 PRINT: INPUT "CONTINUE"; X: GOT05010
6000 CLS: S=1
6010 PRINT: INPUT "ACCOUNT #"; A: J=549: IF A=0 GOT05010
6030 FORR=J TO J+23: IF A(R)=A A(R)=0: GOT06100
6040 NEXT R: J=J+100: IF J<850 GOT06030
6050 INPUT "UNABLE TO LOCATE - WILL YOU ADD "; X: IF X=0 GOT06010
6060 GOSUB 9400: B=A+1: GOT06110
6100 PRINT: "LOCATED IN CAROUSEL "; INT(R/100)
6110 INPUT "MOVE TO "; J: J=(J+100)+49: IF J=0 GOT06010
6120 FORR=J TO J+23: IF A(R)=0 A(R)=A: GOT06200
6130 NEXT R: PRINT: PRINT "UNABLE": GOT06110
6200 CLS: PRINT "LOG ADJUSTMENT": X=INT(F/100)*100: P=A(A+300)
6210 FOR L=X+1 TO X+48: IF A(L)=A A(L)=0: A(A+200)=A(A+200)+1: GOT06240
6220 NEXT L: X=X+100: IF X<G GOT06210
6230 I=0: H=INT(J/100)-5: PRINT "LOGGING"; A(A+200); "SPOTS": GOT04035
6240 H=INT(L/100)*100: A(M)=A(M)-A(A+100): GOT06220
6300 PRINT: A(A+200); " REMAINING": GOT06010
7010 PRINT: INPUT "HOUR "; T: T=INT(T/100)*100
7020 INPUT "AM "; X: CLS: IF X=0 T=T+1200
7030 U=1: V=13: W=25: Z=37
7040 PRINT: "U="; A(T+U); "V="; A(T+V); "W="; A(T+W); "Z="; A(T+Z)
7050 U=U+1: V=V+1: W=W+1: Z=Z+1: IF (U=5)+(U=9) PRINT
7055 IF U<13 GOT07040
7060 PRINT: INPUT "CONTINUE "; X: CLS: IF X=0 GOT05010
7070 T=T+100: IF T>G GOT05010
7080 T=INT(T/100)*100: GOT07030
7090 GOT07040
8010 X=5: R=549: S=1
8020 CLS: PRINT "CAROUSEL "; X: PRINT
8030 PRINT: " = "; A(R); S+12; " = "; A(R+12)
8040 S=S+1: R=R+1: IF S=13 GOT08060
8050 GOT08030
8060 R=R-12: R=R+100: S=1: X=X+1
8070 PRINT: INPUT "CONTINUE "; Z: IF (Z=1)*(X<9) GOT08020
8080 GOT05010
9000 PRINT: INPUT "ENTER BEGINNING TIME "; U: IF U=0 RETURN
9010 INPUT "IS TIME AM "; X: IF X=0 U=U+1200
9020 INPUT "ENTER ENDING TIME "; V
9030 INPUT "IS TIME AM "; X: IF X=0 V=V+1200
9040 D=INT(U/100)*100: U=(D+1)+(U-D)*.8
9050 E=INT(V/100)*100: V=E+(V-E)*.8
9060 PRINT: PRINT "FIRST POSITION = "; U: PRINT "LAST POSITION = "; V
9070 PRINT: INPUT "CORRECT "; X: IF X=0 CLS: GOT09000
9080 RETURN
9200 PRINT: PRINT "ACCOUNT #"; A: INPUT "CODE "; X: A(R): IF A(R)=0 RETURN
9210 INPUT "LENGTH "; Z: A(A+100): PRINT: INPUT "CORRECT "; Z: IF Z=0 CLS: GOT09000
9220 RETURN
9300 Q=749: M=2
9310 IF (X=2)+(X=3)+(X=5)+(X=10) Q=649: M=1
9320 IF (X=1)+(X=13) Q=549: M=0
9330 RETURN
9400 PRINT: INPUT "CODE "; X: A(R): INPUT "LENGTH "; Z: A(A+100)
9410 INPUT "SPOTS "; X: A(A+200): INPUT "PRIORITY "; X: A(A+300): RETURN

```



# Automatic Selection of Plotting Limits

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*Program that determines optimum limits for graphics and charts.*

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**T**he presentation of data in graphic form has many advantages over the tabular printouts that have been standard to the computer field for many years. Plots show trends in data and give an overall picture of the process or event being graphed. In most cases, the plot is not intended to replace the tabular listing; rather, it is a useful supplement that permits the user to observe patterns, tendencies, changes and so forth. To a great extent this frees the analyst from the tedious and time-consuming chore of examining large lists of numerical data.

Nevertheless, if we are to profit from its benefits, the graphical presentation must in some way be referenced to the data. The usual way we do this is by numerically annotating the axes of the plot in a manner that will enable us to tell at a glance the approximate value of the data at any point. We don't need to know the *exact* value; we can always go back to the printout for that. But we do need a reasonable system of reference.

For example, we might have a plot whose x-axis is ten inches long, representing, say, an elapsed time from 0 to 100 seconds. Logically, we would label the axis from 0 to 100 in increments of ten seconds (i.e., 0, 10, 20, 30 . . . 100). See Fig. 1.

But what if we were only interested in the data from 71 to 88 seconds? We could plot the data using the same scale of an-

notation (0 to 100), but in that case most of the plot would be blank, while the data we were interested in would be crammed into less than two inches of length near the end.

Clearly, the best solution is to label one end of the axis 70, the other end 90 and the intermediate points (i.e., the one-inch intervals) in steps of 2. The plot annotation points would then appear as 70, 72, 74 . . . 90 (Fig. 2). This expanded plot would fill most of the page and would still be easy to read.

The process must be repeated every time a plot is produced if we are to always optimize the presentation. The job becomes more difficult, however, when the raw limits that we start out with are of values for which optimum round limits are not easily estimated by "eyeball" techniques. As the total number of plots increases, the burden of selecting appropriate limits increases correspondingly.

This was the situation that confronted a large-scale data processing operation for which I designed and implemented a production graphics system some years ago. At its peak the system generates in excess of 30,000 plots per month (more than a thousand plots a day, seven days a week) and 4000 per month during slack periods. Obviously, it wasn't practical to hire a whole crew of people just to eyeball data and select plotting limits.

Consequently, I incorporated into the system a small subroutine whose function is to examine the raw minimum and maximum values of the data for each axis. Then, based on the given lengths of the axes, it returns optimized round limits and

increments. The plots are thereby spread out over as much of the page as possible, and the numerical annotation is easy to interpret.

Other parts of the graphics software package write the numerical annotation (as well as all titles and other written legends) directly onto the plots. These graphs are in every respect complete the moment they come off the plotter, and they are inserted directly into printed reports.

Few computer operations have a volume of graphics production that anywhere near approaches that of the system described above, but even the smallest hobby and business systems can make use of its features. Of course, fully optimized plotting limits may not be suitable in every instance; it may be desirable in some cases to sacrifice optimization for standardization. These few cases notwithstanding, the user frequently finds it valuable to generate a set of fully optimized test plots before deciding on a standard layout.

## The Round Limits Subroutine

Listing 1 is a BASIC version of the Round Limits subroutine used in the production graphics system described above. (The original program was a FORTRAN subroutine written in 1969, which, in turn, was a modified version of an assembly-language routine that I wrote in 1966.) The BASIC program is designed as a subroutine and is extremely easy to use. It consists of only about 60 executable statements and requires only a few milliseconds of execution time.

Full instructions on the use of

the subroutine are given by the remarks contained within the program, but briefly the procedure is as follows: The raw minimum and maximum values, as well as the length of the axis, are supplied by the main program. This is done by setting A1, B1 and L, respectively, equal to those values. A GOSUB 8000 is executed, and upon return from the subroutine the round minimum, round maximum and round increment will be found in variables A, B and C, respectively. The foregoing procedure is repeated for each axis of the plot for which round limits are desired.

Note that for the purposes of this subroutine the words "minimum" and "maximum" simply refer to the numerical values at the two extremities of a given axis. There are, in fact, no restrictions on their values, and either may be algebraically greater or less than the other and may be either positive or negative.

The method by which you initially obtain the raw minimum and maximum values is determined by the nature of the operation that is generating the data to be plotted. If, for example, the data is being written onto a file for later use by the graphics software, it is a simple matter to detect the minimum and maximum values of each parameter as it is generated or written out. The actual method must suit the circumstances, of course, but in any case it is a process that must be completed before the Round Limits routine is called.

The length of the axis may be in any units, where the units of length refer to the intervals at which the numerical annotation



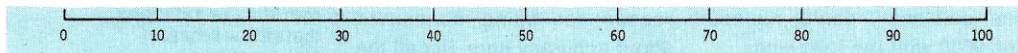


Fig. 1. If an axis of a plot is ten units long and is to represent an elapsed time from 0 to 100 seconds, it is a simple matter to annotate the axis in a manner that is easy to read.

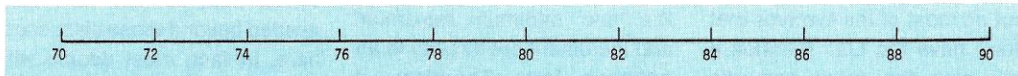


Fig. 2. Suppose that even though all of the same data as described in Fig. 1 is available to us, we are actually interested in displaying only the portion that lies between 71 and 88 seconds. Assuming that we use the same length axis, the most readable presentation is obtained by annotating the axis from 70 to 90 in increments of 2.

is to appear. For example, plots are frequently drawn on a grid with one-inch spacing between major divisions, and the numerical annotation is placed at these same intervals. In such cases you would simply specify the axis length in inches.

Another common situation is to generate a plot on a video display where the grid has no direct relationship to conventional units such as inches or centimeters. (Indeed, the underlying software is in all probability concerned with pixels and bit patterns, rather than lengths.) Suppose that a grid on such a display is divided into five equal intervals, and that the numerical annotation is to appear at each of these intervals. These arbitrary (but equal) intervals become our units of measure, so the length therefore has a value of 5.

Though it is customary to arrange plot axes so that their lengths are integral multiples of the basic units of measurement, the Round Limits subroutine does not require that this be done. For example, you could declare an axis length of 6.3 inches. The returned round values, A and B, would correspond to the two extremities of the axis (i.e., 0 and 6.3 inches), and the value C would be the round increment between each whole one-inch interval. The value of the axis at the far end (at 6.3 inches) would not be a round number (unless by coincidence), but the annotation at every whole interval from 0 through 6 inches *will* be round.

#### Specific Implementation Considerations

The key to a successful round limits routine lies not in the

selection of the minimum and maximum values, but in the selection of the appropriate increment per unit of axis length. An examination of Listing 1 will disclose that the increment is computed first, and then the minimum and maximum values are allowed to fall into place on the basis of the computed round increment and the given axis length. The value of the raw increment is factored into a fractional part (called the mantissa) and a power of ten (the characteristic). The mantissa is rounded up to some convenient standard value and then recombined with the characteristic to arrive at the computed round increment.

The decision as to just what is a "convenient standard value" for the mantissa is purely subjective. Most people would agree that a mantissa of 1, yielding increments of 1, 10, 100, 1000, etc. (or .1, .01, .001, etc.), is convenient. The same is true for a mantissa of 5 (for increments of 5, 50, 500, etc., .5, .05, .005, etc.). But what about a mantissa of 6, which yields increments of 6, 60, 600, etc. (or .6, .06, .006, etc.)? Is an axis labeled from 120 to 540 in steps of 60 (see Fig. 3) satisfactory for your purposes?

This Round Limits routine contains a table of standard increment mantissas (lines 8690 and 8700) that may be changed to suit your needs. As given in Listing 1, the table contains 12 different values, and that is the form that has been satisfactory for most of my applications.

Having a large number of entries in the table ensures that the data will be spread out as much as possible along each axis of the plot. On the other hand, it introduces mantissas

that may not be visually appealing on your plots. If this is the case for you, change the table so that it includes only the values 1.0, 2.0, 2.5, 5.0 and 10.0. You will also need to change both the dimension of S and the



Fig. 3. The use of certain values in the table of standard increment mantissas may produce plot annotation values that are not appealing to all people. In this example, a seven-unit axis is labeled from 120 to 540 in steps of 60. Some people may find this perfectly readable, while others may not like it at all. The values within the table may be changed to suit your needs.

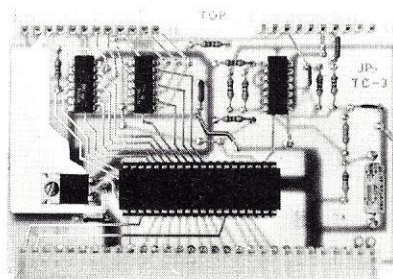
value of M to 5 (to correspond to the number of entries in the table) at lines 8530 and 8560.

You can actually use any (and as many) values you care to in the table. The only restrictions are that the values must be positive, must be listed in order of increasing magnitude, and the last entry in the table must be equal to exactly ten times the value of the first entry. As pointed out above, the dimension of S and the value of M must be equal to the number of entries in the table.

At lines 9150, 9280 and 9450 the \*\* operator has been used to signify exponentiation. If your interpreter does not accept the double asterisk, replace it with

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the appropriate symbol (usually t) in these three lines.

A base 10 logarithm is computed in line 9080. The interpreter that I use has a base 10 log function (called LGT), so I made use of it in order to obtain the greatest possible accuracy in the result. If your set of library functions doesn't include this

one (and many don't), replace line 9080 with the following:

```
9080 LET P = LOG(C2)/LOG(10.0)
```

This is not the most efficient way to compute a base 10 log, but on most of the systems that don't have the LGT function it will give the most accurate results.

Incidentally, there is a good

reason for being concerned about accuracy here. Recall the earlier example where data running from 0 to 100 is plotted along a 10-inch axis. In this case the "raw" minimum, maximum and increment are already in an optimum form. Therefore, if these values are supplied to the Round Limits routine, it should

```
9580 IF I >= 0.0 THEN 9583
9581 LET I = -INT(ABS(I))
9582 GO TO 9610
9583 LET I = INT(I)
```

There should be no further system-dependent changes needed beyond those discussed here. In fact, most people will probably need to make only the changes regarding the exponentiation operator and the log function. You can save a considerable amount of storage space by deleting the remark statements when you implement the subroutine, but if you do so, keep a copy of this article, including Listing 1, on file for future reference.

Figs. 4a through 4f show some typical examples of use of the Round Limits routine. In each case a raw minimum, raw maximum and an axis length are listed. If these values are supplied to the Round Limits subroutine, it will return the optimized round limits and increment. A sample annotated axis is illustrated to show what the figures would look like on a finished plot.

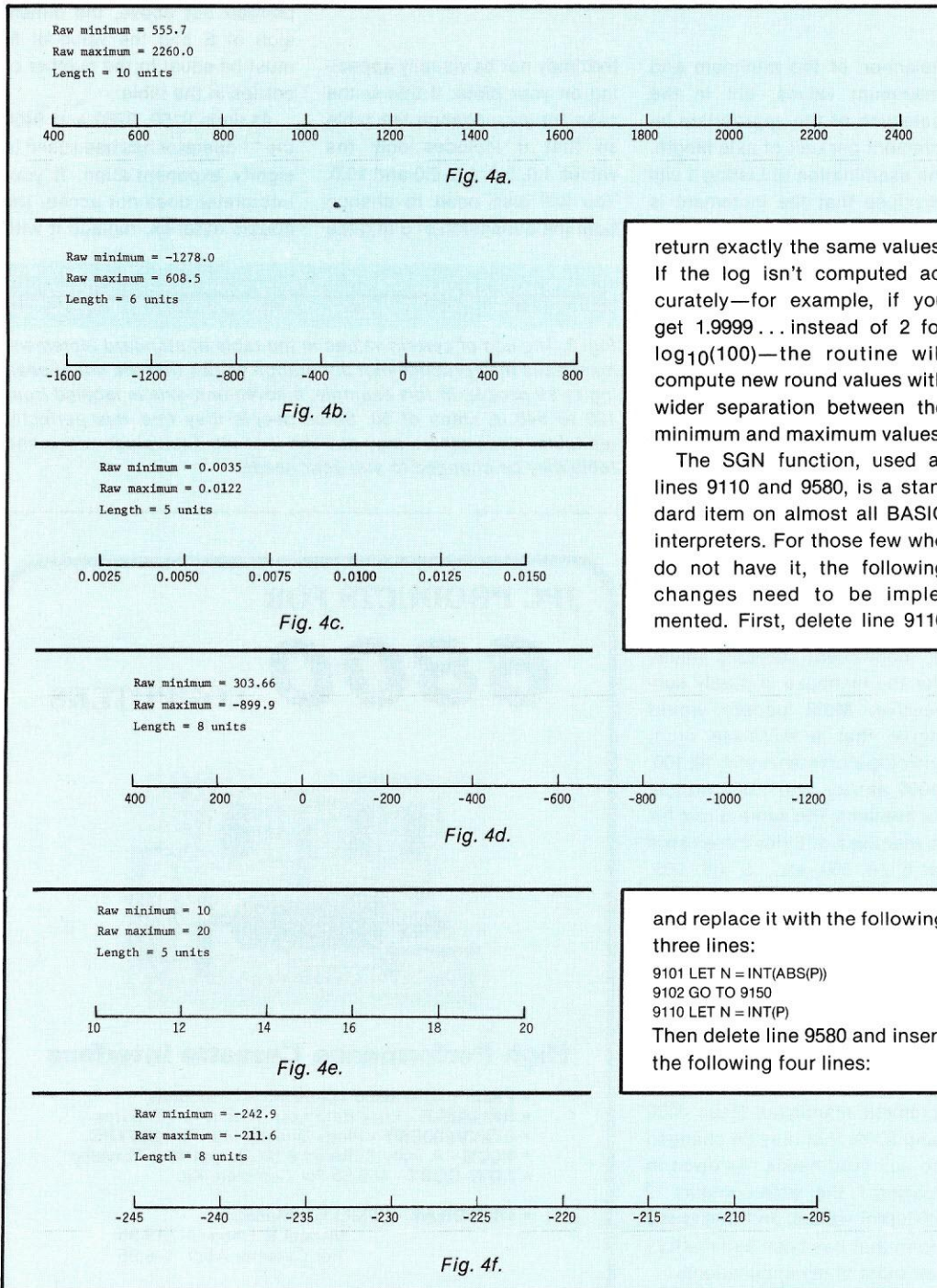
### Summary

The use of computer graphics is becoming increasingly widespread as more and more businesses and hobbyists recognize its advantages. The ideal automated graphics system permits the user to process and display large quantities of data with a minimum of operator intervention. Those features that increase the ease of interpretation of data, while simultaneously decreasing the user's workload, are important elements in a complete graphics system.

The implementation of the Round Limits routine represents a significant step toward achievement of that goal with only a negligible expenditure in program storage and execution time. No system is too small to profit from its benefits. ■

### Reference

William, D. Johnston, "Computer Graphics in a Production Environment," Transactions of the Twenty-Third Conference of Mathematicians, NASA-Langley Research Center, May 11, 1977.



Figs. 4a-4f. Several examples are shown to illustrate the results that can be obtained with the Round Limits routine. In each case a raw minimum, raw maximum and an axis length are listed. If these figures are supplied to the Round Limits routine, it will return the optimized round limits and increment. The sample annotated axis in each illustration shows how these round figures would appear on a finished plot. Compare these samples to the appearance a plot would have if the raw minimum and maximum values were used directly.



Listing 1. Round Limits subroutine.

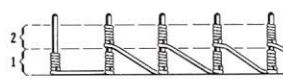
```

8000 REM      ROUND LIMITS ROUTINE FOR GRAPHICS.
8010 REM
8020 REM      WILLIAM D. JOHNSTON -- APRIL, 1979
8030 REM
8040 REM
8050 REM      THIS ROUTINE GENERATES OPTIMIZED ROUND LIMITS
8060 REM      AND INCREMENTS FOR PLOTTING PURPOSES, BASED ON
8070 REM      GIVEN RAW MINIMUM AND MAXIMUM VALUES AND A
8080 REM      PREDETERMINED AXIS LENGTH.
8090 REM
8100 REM      FOR THE PURPOSES OF THIS ROUTINE, 'MINIMUM'
8110 REM      AND 'MAXIMUM' SIMPLY REFER TO THE NUMERICAL
8120 REM      VALUES AT THE TWO EXTREMITIES OF A GIVEN AXIS.
8130 REM      THERE ARE NO RESTRICTIONS ON THEIR VALUES, AND
8140 REM      EITHER MAY BE ALGEBRAICLY GREATER OR LESS THAN
8150 REM      THE OTHER.
8160 REM
8170 REM      THE ROUTINE IS DESIGNED FOR APPLICATIONS WHERE
8180 REM      THE NUMERICAL ANNOTATION ON THE PLOT IS TO BE
8190 REM      PLACED AT INTEGRAL MULTIPLES OF THE BASIC
8200 REM      UNITS OF AXIS LENGTH (INCHES, CENTIMETERS,
8210 REM      ETC.).
8220 REM
8230 REM
8240 REM      THE FOLLOWING PARAMETERS MUST BE DEFINED
8250 REM      BEFORE THIS SUBROUTINE IS CALLED:
8260 REM
8270 REM      A1 IS THE RAW GIVEN 'MINIMUM' SUPPLIED BY
8280 REM      THE CALLING ROUTINE.
8290 REM
8300 REM      B1 IS THE RAW GIVEN 'MAXIMUM' SUPPLIED BY
8310 REM      THE CALLING ROUTINE.
8320 REM
8330 REM      L IS THE GIVEN LENGTH, IN ANY UNITS OF
8340 REM      MEASURE, SUPPLIED BY THE CALLING
8350 REM      ROUTINE.
8360 REM
8370 REM
8380 REM      THE FOLLOWING PARAMETERS ARE COMPUTED BY THIS
8390 REM      SUBROUTINE:
8400 REM
8410 REM      A IS THE COMPUTED ROUND 'MINIMUM' VALUE.
8420 REM
8430 REM      B IS THE COMPUTED ROUND 'MAXIMUM' VALUE.
8440 REM
8450 REM      C IS THE COMPUTED ROUND INCREMENT (PER
8460 REM      UNIT OF AXIS LENGTH).
8470 REM
8480 REM
8490 REM
8500 REM
8510 REM
8520 REM
8530 DIM S(12)
8540 REM      THE VALUE OF M MUST BE EQUAL TO THE DIMENSION
8550 REM      OF S.
8560 LET M = 12
8570 REM      THE TABLE OF STANDARD INCREMENT MANTISSAS IS
8580 REM      READ INTO THE ARRAY S. IT MAY CONTAIN ANY
8590 REM      NUMBER OF STANDARD INCREMENTS (AS LONG AS S IS
8600 REM      DIMENSIONED BY THAT SAME NUMBER), AND MAY
8610 REM      CONTAIN ANY DESIRED VALUES FOR THESE INCRE-
8620 REM      MENTS. HOWEVER, THE INCREMENTS IN THE TABLE
8630 REM      MUST BE LISTED IN ORDER OF INCREASING VALUE,
8640 REM      AND THE LAST ENTRY IN THE TABLE MUST BE EQUAL
8650 REM      TO TEN TIMES THE VALUE OF THE FIRST ENTRY IN
8660 REM      THE TABLE.
8670 FOR I = 1 TO 12
8680 READ S(I)
8690 DATA 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 6.0, 7.0
8700 DATA 8.0, 9.0, 10.0
8710 NEXT I
8720 RESTORE
8730 REM      SAVE THE GIVEN MINIMUM AND MAXIMUM VALUES.
8740 LET A2 = A1
8750 LET B2 = B1
8760 REM
8770 REM      COMPUTE THE RANGE BETWEEN THE GIVEN MINIMUM
8780 REM      AND GIVEN MAXIMUM VALUES. THE SIGN OF THE
8790 REM      COMPUTED RANGE WILL INDICATE DIRECTION.
8800 REM      (POSITIVE INDICATES THAT A1 IS LESS THAN B1.
8810 REM      NEGATIVE INDICATES THE OPPOSITE).
8820 REM
8830 LET R = B2 - A2
8840 REM
8850 REM      IF THE GIVEN MINIMUM AND MAXIMUM VALUES WERE
8860 REM      EQUAL TO EACH OTHER, OR IF THE GIVEN AXIS
8870 REM      LENGTH WAS NOT GREATER THAN ZERO, THEN SET
8880 REM      ALL COMPUTED VALUES TO ZERO AND RETURN TO THE
8890 REM      CALLING PROGRAM, AS NOTHING CAN BE DONE.
8900 REM
8910 IF R = 0.0 THEN 8930
8920 IF L > 0.0 THEN 9030
8930 LET A = 0.0
8940 LET B = 0.0
8950 LET C = 0.0
8960 RETURN
8970 REM
8980 REM      COMPUTE THE ABSOLUTE VALUE OF THE GIVEN INCRE-
8990 REM      MENT. THIS IS THE RAW INCREMENT AS COMPUTED
9000 REM      FROM THE GIVEN MINIMUM AND MAXIMUM VALUES, AND
9010 REM      THE LENGTH OF THE AXIS.
9020 REM
9030 LET C2 = ABS(R/L)

```

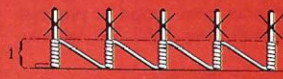
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# Disk Addition

## *Add a floppy disk to Motorola's MicroChroma 68 color graphics kit.*

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**M**otorola developed the MicroChroma 68 kit as an evaluation tool for their 6847 color graphics video display generator, but the MicroChroma 68 is much more than just a color graphics demonstrator. It is a versatile 6800 computing system complete with Kansas City Standard cassette interface, a 2K ROM operating system (TVBUG) and provision for up to 15K of RAM (6K for color display, 8K for user programs and 1K for system use).

Since MicroChroma connects directly to any color television set, all you need to complete the system are an inexpensive keyboard, a cassette recorder and a power supply. For more information about TVBUG and the MicroChroma kit, refer to Tim Ahrens' article in the June 1979 issue of *Kilobaud Microcomputing* ("TVBUG," p. 48).

After you get the MicroChroma kit running, you can add a mini-disk system.

### **The EXORcisor Bus**

The MicroChroma circuit card is designed to plug into and get power from Motorola's 86-pin EXORcisor bus, which is different than the S-100 and SS-50 buses found in hobby computers. However, it is the standard bus for most 6800-based industrial computing equipment. The EXORcisor bus has not been widely accepted by home computerists until recently because

the modules cost more than corresponding hobby bus modules.

In addition to Motorola, there are several manufacturers that produce memory and various I/O modules (cards) for the EXORcisor bus. For instance, Percom Data now produces a 64K dynamic memory and a mini-disk system for the EXORcisor.

### **The Percom Mini-Disk**

The Percom EXORcisor bus-compatible mini-disk (LFD-400EX) controller contains all of the ROM and RAM needed to support the disk operating system. This eliminates any burden on the memory resources of the MicroChroma.

Much of the 6800 disk software Percom developed for the EXORcisor and SS-50 bus computers is easily adapted for use with the MicroChroma and TVBUG. The adaptation usually amounts to little more than changing subroutine vectors to match the routines in TVBUG.

### **Connecting the Parts**

Although the MicroChroma card plugs into the EXORcisor bus, the only connection it makes to the bus is for +5 volt power and ground. It is necessary to buffer the address and data bus signals and connect them to the appropriate contacts on the EXORcisor bus connector. The applications booklet supplied with the MicroChroma kit provides all of the necessary information for connecting the kit to the EXORcisor bus. The buffer ICs may be mounted in the wire-wrap area just above the bus connector.

MicroChroma can accommodate more RAM memory than most other evaluation kits; however, you may eventually want to add even more memory. Motorola, Creative Micro Systems and Percom Data manufacture memory cards for the EXORcisor bus.

In the system pictured we added our own memory and disabled the RAM memory on the MicroChroma card by removing the 74LS138 RAM selector chip (U22). Again, the MicroChroma applications booklet provides much useful information for adding and configuring additional memory.

The various circuit cards may be connected together by mounting and interconnecting several 0.156 inch 86-pin connectors. A more convenient connection is possible with the Percom 5-slot motherboard or the Motorola 5- or 10-slot Micro module card cage. We use the Motorola Micro module power supply; however, any of the low-cost open-frame power supplies that deliver 5 volts at 4-6 Amps and  $\pm 12$  volts at 1 Amp should be more than adequate.

Motorola recommends a modified Cherry keyboard; we use an inexpensive George Risk keyboard. Actually, any ASCII keyboard that generates a low-active strobe that is maintained as long as a key is depressed should work well. Keyboards that generate a short strobe pulse when a key is depressed are unsatisfactory because the keyboard scanning routine in TVBUG may miss the strobe pulse.

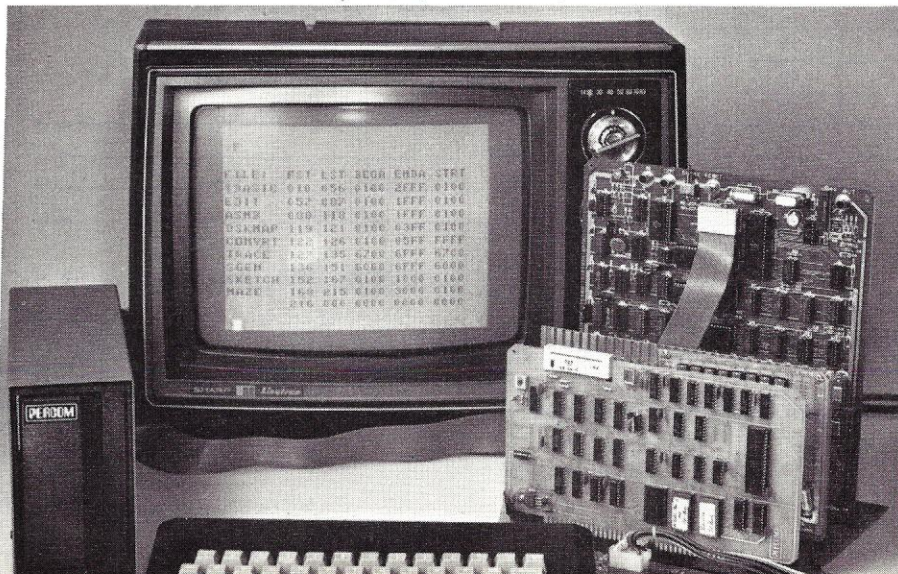
### **Where to Get the Parts**

You can purchase the MicroChroma kit from nearly any Motorola distributor; however, the kit only contains the LSI devices and the PC card. Austin Electronics also sells the MicroChroma kit. In addition, they have a kit of all the extra parts needed to complete the kit.

The Percom products are available directly from Percom Data Co., Inc. When ordering, be sure to mention you intend to use the mini-disk with TVBUG.

Creative Micro Systems (CMS) manufactures a broad line of EXORcisor bus-compatible memory cards and I/O modules. The entire CMS line is available from Advanced Computer Products (PO Box 17329, Irvine CA 92713). ■

*Percom's system for the MicroChroma 68.*





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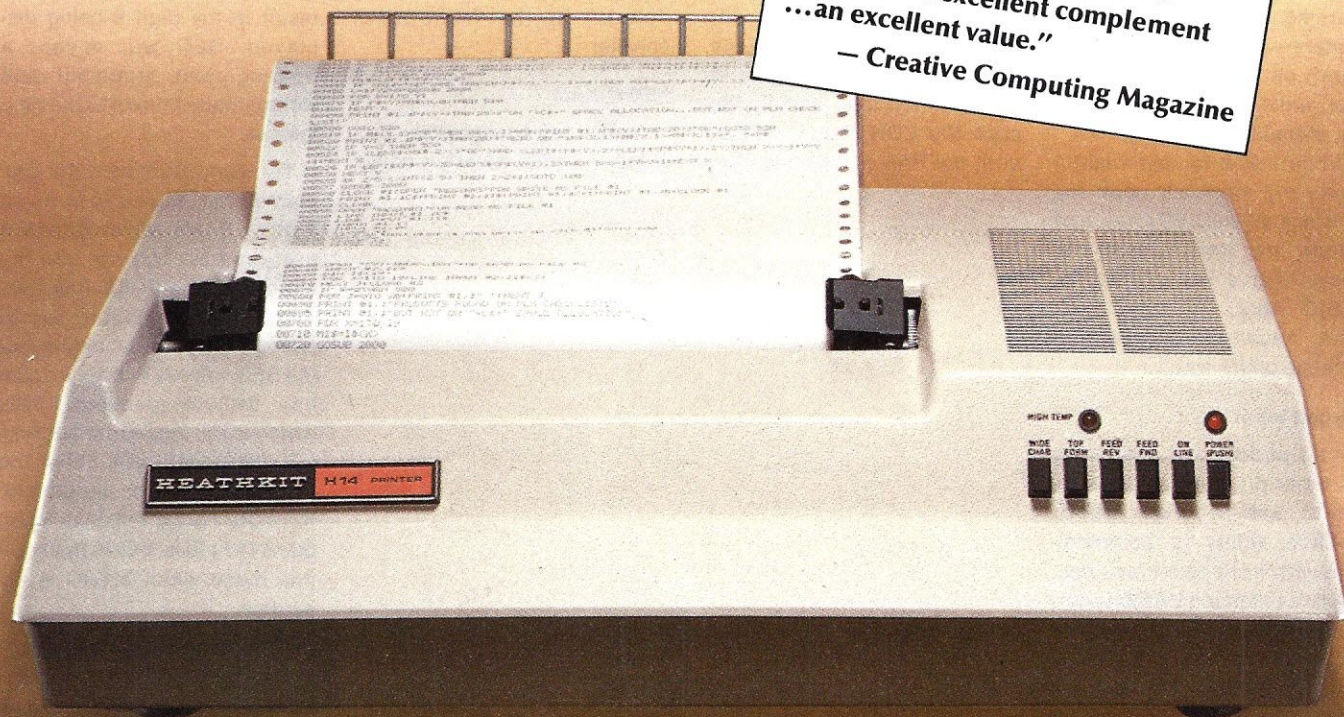
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# An H8 in the Darkroom

*There may be some techniques for using the H8 panel monitor, via BASIC, that you haven't even contemplated. If such is the case, you're going to read about them in this article.*

As part of preparing "Heath's H8 Is a Winner!" (Kilobaud No. 20, p. 70), I had to submit some black and white photos. While assembling my darkroom equipment, I once again experienced an old yearning shared by all photo printers—a darkroom clock to count on... and see... and hear while exposing, developing, stopping and fixing.

While I was in this wishful mood, my eyes fell upon my H8's keypad and LED array, and I knew my timer wasn't far away. After a few minutes of BASIC work, the timer was done, negatives printed and package on its way.

## Keypad Input

As a prologue to describing the timer program, a few comments are in order about BASIC's ability to communicate with front-panel facilities. Heath's Extended BASIC is normally configured for operator input from the console (Heath H9, ADM 3A, etc.). However, an alternate input facility is BASIC's PAD function. If Extended BASIC were loaded, and you were to enter \*PRINT PAD(0), BASIC would lock up until you pressed one of the keys on the keypad—then the value entered would be displayed on the console, and would be followed by the \* prompt character. See Fig. 1 for an example of this.

Try the routine in Fig. 2 to discover what number is assigned to each key—remember that should you enter a CONTROL-C to break out of the routine, BASIC will still wait for the key entry on line 10 prior to servicing the CONTROL-C (as with most Heath software products, BASIC accepts all console input as interrupts, and in this case the CONTROL-C is held until the PAD function is com-

pleted by pressing any key on the keypad). The assignments are shown in Fig. 3.

BASIC uses PAM8's (Heath Panel Monitor) routine for reading the keypad, so each entry is debounced and followed with a "click" in the front-panel speaker.

## LED Output

Heath has thoughtfully provided a BASIC function called

SEG to return a numeric value appropriate to displaying a zero-through-nine digit on one of the 7-segment LEDs. Function SEG will not accept negative arguments, and arguments greater than nine will generally result in the digit 8 being displayed. SEG will accept a floating-point argument and will truncate it down to the next integer.

Try using SEG with the program in Fig. 4. Line 10 turns on a bit in PAM8, which allows a user program to write into the LEDs with the POKE function. After a value is input by line 20 and its SEG value displayed, the SEG value is POKED in location 040.013 (decimal 8203), which is the high-order address LED (left-most LED). Either the command-form or statement-form CNTRL 2,0 will once again blank the LEDs; this is their normal mode when BASIC is executing.

To view all possible LED segment combinations, enter and execute the program in Fig. 5. Lines 20-40 blank out the LEDs, and a FOR loop is entered. After the current value of loop index "I" is displayed in the left-most LED, the index is decoded into hundred-ten-unit values that are displayed on the three right-most LEDs.

Because of line 130 the loop will pause until the space bar on the console is pressed (with-

|     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|
| 0   | 1   | 2   | 3   | 4   | 5   |
| 72  | 95  | 111 | 113 | 115 | 127 |
| 128 | 129 | 131 | 132 | 141 | 143 |
| 144 | 146 | 152 | 156 | 160 | 164 |
| 178 | 189 | 187 | 191 | 194 | 198 |
| 200 | 206 | 215 | 222 | 223 | 224 |
| 237 | 237 | 238 | 239 | 241 | 243 |
| 247 | 251 | 252 | 253 | 254 | 255 |

Table 1. LED segments displayed from several decimal values.



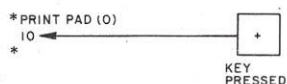


Fig. 1. Simple keypad test.

out the pause, each combination is displayed less than 0.1 second). As you continue to examine these patterns, you'll find many to be nonsense and a few that may be useful in future applications. Table 1 illustrates some that may be of interest.

Fig. 6 identifies the decimal value required to turn on each segment in an LED if POKEd to the correct address in the CNTRL 2,1 mode. These values can be placed in an array (S(1)=253, S(2)=251, S(3)=247...) and combined by the AND function to form any desired segment combination. For example, the letter "J" could be displayed by J = S(2)AND S(3)AND S(4)AND S(5) followed by POKE 8203,J.

#### Speaker

Heath's Panel Monitor (PAM8), everpresent in the first 1K of ROM and a few bytes of RAM, includes in its treasure of goodies a subroutine called HORN at 002.140. When executed, it will turn on the 1000 Hz panel speaker for x milliseconds, where x is the current value in register (A) times 2. To use in BASIC, configure Extended BASIC with some space at the top of your RAM for a USR routine, load the routine to be memory resident with BASIC, and set Extended BASIC's USR pointer to the start of your routine.

Assuming you have 16K of RAM and you've left 1K at the top for USR routines when you did your BASIC configuration (SYSGEN), the six-byte USR function in Fig. 7a will allow BASIC access to the speaker. Since these six bytes can be easily represented in decimal, as shown in Fig. 7b, the USR function can be loaded by a simple POKE to the correct address (134.000 = decimal 23552). The POKE is also suitable for configuring BASIC to point to 134.000 as the USR function (do this with POKE

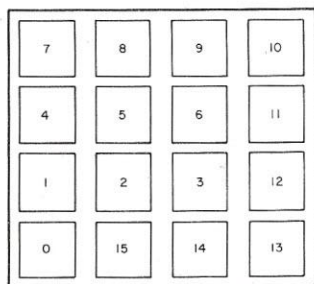


Fig. 3. Key assignments.

17268,92).

A couple of observations on USR functions: Although Heath doesn't step you through their use in the H8 *Software Reference Manual*, there is a wealth of hints that can be dug out regarding use of internal BASIC routines. Also, since BASIC can be dynamically reconfigured to change the pointer to the USR function through POKEs to 17267 and 17268, several USR

```
10 PRINT PAD(0)
20 GOTO 10
```

Fig. 2. Pressing keys will confirm values.

```
10 CNTRL 2,1
20 INPUT I
30 PRINT SEG(I)
40 POKE 8203,SEG(I)
50 GOTO 20
```

Fig. 4. Test of SEG function.

```
10 CNTRL 2,1
20 FOR I=0 TO 8
30 POKE 8203+I,255
40 NEXT I
50 FOR I=0 TO 255
60 POKE 8203,I
70 H=INT(I/100)
80 POKE 8209,SEG(H)
90 T=INT((I-H*100)/10)
100 POKE 8210,SEG(T)
110 U=INT(I-H*100-T*10)
120 POKE 8211,SEG(U)
130 PAUSE
140 NEXT I
```

Fig. 5. LED combination program.

functions can be in high memory and the appropriate one selected by correct loading of the USR pointer.

#### The Timer

The Program listing combines these three features of the H8 (keypad input, LED output and speaker) with PAM's

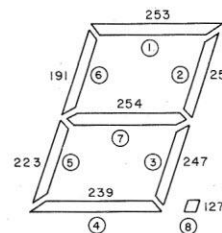


Fig. 6. LED segments and values.

#### Program listing.

```
10 REM PHOTO TIMER USING H-8 LED'S, KEYPAD, AND FRONT-PANEL SPEAKER.
20 REM
30 REM FOLLOWING LOADS A USR ROUTINE TO CLICK FRONT-PANEL SPEAKER
40 POKE 17268,92
50 DATA 62,1,205,96,2,201
60 P9=23552
70 FOR I=0 TO 5
80 READ I1
90 POKE P9+I,I1
100 NEXT I
120 REM P9 SET TO POINT TO MEMORY LOCATION THAT SETS 'CLICK' LENGTH.
130 P9=P9+1
140 DIM M(3),Q(3,9)
150 FOR I=0 TO 9
160 Q(1,I)=SEG(I)
170 Q(3,I)=SEG(I)
180 NEXT I
190 DATA 1,115,72,96,50,36,4,113,0,32
200 FOR I=0 TO 9:READ Q(2,I):NEXT I
210 CNTRL 2,1
220 REM "A" POINTS TO FIRST LED, AND "C" TO HIGH-ORDER BYTE OF CLOCK.
230 A=8203
240 C=8220
250 REM BLANK-OUT DIGITS
260 GOSUB 5000
1000 REM =====
1010 REM          C O M M A N D      L O O P
1020 REM =====
1030 REM "+" COMMAND (VALUE 10) = EXECUTE COUNT
1040 REM "/" COMMAND (VALUE 13) = EXECUTE UPDATE
1050 X1=PAD(0)
1060 IF X1=10 THEN GOSUB 3000
1070 IF X1=13 THEN GOSUB 2000
1080 IF (X1=10 OR X1=13) THEN 1050
1090 REM == ERROR - SOUND BELL AND TRY AGAIN
1100 PRINT CHR$(7);
1110 GOTO 1050
```



```

2000 REM =====
2010 REM SUBROUTINE TO UPDATE COUNTER
2020 REM 3 DIGITS REQUIRED.....LAST MUST BE '5' OR '0'
2030 REM BLANK DISPLAY
2040 GOSUB 5000
2050 REM GET THREE NUMBERS FROM KEYPAD AND STORE IN ARRAY "M"
2060 REM          IN ORDER 3,2,1
2070 X=PAD(0)
2080 IF X<10 THEN 2130
2090 REM ERROR: VALUE MUST BE 0 TO 9
2100 PRINT CHR$(7);
2120 GOTO 2070
2130 Q=Q(3,X)
2140 M(3)=X:POKE A,Q
2160 X=PAD(0)
2180 IF X<10 THEN 2230
2200 PRINT CHR$(7);
2220 GOTO 2160
2230 Q=Q(2,X)
2240 M(2)=X:POKE A+1,Q
2260 X=PAD(0)
2280 IF (X=0 OR X=5) THEN 2330
2300 PRINT CHR$(7);
2320 GOTO 2260
2330 Q=Q(1,X)
2340 M(1)=X:POKE A+2,Q
2360 Z1=M(1):Z2=M(2):Z3=M(3)
2999 RETURN
3000 REM =====
3010 REM COUNTS DOWN DIGITS IN ARRAY "M"
3100 SET COUNTER TO ZERO
3120 POKE C,0: POKE C-1,0
3140 Z=1: GOTO 3180
3145 REM TIMER LOOP:
3150 GOSUB 6000
3180 X=PEEK(C)
3200 IF X<>Z THEN 3180
3205 U2=USR(U2)
3210 Z=Z+1: IF Z>255 THEN Z=Z-256
3215 M(1)=M(1)-5
3220 IF M(1)>=0 THEN 3150
3225 M(1)=5
3280 M(2)=M(2)-1
3300 IF M(2)>=0 THEN 3150
3320 M(2)=9
3340 M(3)=M(3)-1
3360 IF M(3)>=0 THEN 3150
3380 POKE P9,20:U2=USR(U2)
3390 M(1)=Z1:M(2)=Z2:M(3)=Z3
3410 GOSUB 6000
3420 POKE P9,1
3999 RETURN
5000 REM =====
5010 REM BLANK OUT LED'S
5020 FOR I=A TO A+8
5030 POKE I,255
5040 NEXT I
5999 RETURN
6000 =====
6010 REM UPDATE DIGITS
6020 I=A
6030 FOR Q=3 TO 1 STEP -1
6040 POKE I,Q(Q,M(Q))
6050 I=I+1
6060 NEXT Q
6999 RETURN
9999 END

```

interrupt-driven clock to provide a timer that is easy to use in the dark, and quite repeatable.

Repeatability rather than absolute accuracy is stressed; for both black and white and color, most darkroom workers establish procedures based on conditions that they know can be obtained for each session. For example, I *always* make my contact sheets with the film plane of the enlarger 24 inches above the easel, lens set for f3.5 and in focus, negative carrier empty, RC paper, 3½ seconds exposure and developer at about 75° F—this works every time.

My approach on the timer program was to use the high-order byte of the 16-bit clock. Its least significant bit is incremented by an interrupt every 2 ms, so the least significant bit in the high-order byte (the ninth bit in the 16-bit register) is incremented every 0.512 seconds. This provides crystal-controlled repeatability at 2.4 percent absolute accuracy, so a 60-second countdown will really take 61.44 seconds... but it will do it every time!

BASIC just doesn't process fast enough to use the low-order byte. To prove this for yourself, execute the following series of repetitive PEEKs at the low-order byte: FOR I=1 TO 1000: PRINT PEEK(8219);NEXT I. You'll get numbers like 74 89 104 122 140 158 175 194 212 231 249 11 27 and so on, if you're running your console at 4800 baud—the spread will be greater if your console is slower.

Now substitute 8220 in the PEEK and reexecute; at 600 baud you'll see six to ten duplications of the high-order byte before it is incremented (at 9600 baud, 16 to 23 duplications). It should be clear that the low-order byte cannot be processed with BASIC.

In lines 10-100 of the timer program the USR routine is loaded and BASIC configured for USR with the POKE to 17268 (134.164). P9 is set to modify the second byte in the MVI instruction (via a POKE), which loads register (A) with the time the horn is to be turned on.



In lines 140-200 a matrix Q is defined. Its first and third rows are used to store the appropriate values to display integers on the LEDs. Since the timer's range is 99.5 to 00.0, the second row of Q includes data from line 190 to display integers with decimal points. After the LED write bit is turned on, and pointers to the LED's RAM and the clock are established, we enter the command loop.

The program is set up so that as soon as you enter RUN, you can turn off the CRT console. All program functions are controlled by the keypad. Line 1050 reads a keypad value, which is subsequently tested. Should the value be in error, the console BELL is sounded, if the console is on, and the program waits for a correct entry—either upper-right or lower-right keys.

The UPDATE function should be first selected to place a

value in the counter array "M." Upon entry into UPDATE at line 2000, the display is blanked via subroutine 5000, and three key entries are processed. Should they be in error (i.e., not be values 0-9 for the first two, or 0 or 5 for last), the BELL will sound (if the console is on) and that digit will not display on the LED panel; otherwise the selected digit will display. After the third correct key entry, three scalars that save the digits will be updated (Z1, Z2, Z3) and control returned to the command loop.

Upon entry to COUNTER, the clock bytes are zeroed to maximize accuracy of the first half second, and the target ("Z") for comparison to the high-order byte set to 1. The high-order clock byte is then tested until it equals the target, which is a delay of 512 ms. When they are equal the speaker is "clicked" (useful if the printer is "dodg-

ing" or "burning" the print) and the target incremented.

The low- to high-order values in the counter array are decremented, as required, and the display updated via subroutine 6000. The timer loop is reentered at line 3180. When the "tens" member of the counter array goes negative, time is up and the subroutine is exited after sounding a 10 ms beep on the speaker.

### What's Missing

Direct control of the enlarger and safelight would be an obvious enhancement. Announcement by Mullen Computer Boards of an H8 Relay/Optoisolator Control Board should make this possible. Although I have no experience with the Mullen board, I believe the program modifications shown in Fig. 8 should provide the required control. These modifica-

tions assume that a 2 to port 144, would activate relays to turn on the safelight and off the enlarger while a 1 to port 144, would turn off the safelight and on the enlarger.

Another enhancement: To stop the count while it is counting, add line 3190—IF PIN(240) <> 255 THEN 3380. Pressing any key on the keypad will cancel the count.

### Wrap-up

You've reviewed how some H8 PAM facilities are available to the BASIC programmer. Whether you are counting, clocking, displaying error or record numbers, or alpha messages such as 140,222,222,198, 222,254,254,254,254 (Error---), or warning a data-entry operator with a speaker click, beep, or howl—these facilities are available for the creative designer. ■

```
134.000 076 001 MVI A,001Q
134.002 315 140 002 CALL HORN
134.005 311 RET
```

Fig. 7a. USR program to interface with speaker.

```
Octal: 076, 001, 315, 140, 002, 311
Decimal: 62, 1, 205, 96, 2 201
```

Fig. 7b. Decimal values for POKEing.

```
270 OUT 100,2
1035 REM "*" COMMAND (VALUE 10) = EXECUTE FOCUS
1065 IF X1=12 THEN GOSUB 4000
1080 IF (X1=10 OR X1=12 OR X1=13) THEN 1050
3130 OUT 100,1
3370 OUT 100,2
4000 REM =====
4010 REM FOCUS SUBROUTINE
4020 OUT 100,1
4030 REM WAIT FOR ANY KEYPAD ENTRY TO GO BACK.
4040 X=PAD(0)
4050 OUT 100,2
4999 RETURN
```

Fig. 8. Probable mods to add to Mullen Relay Board.

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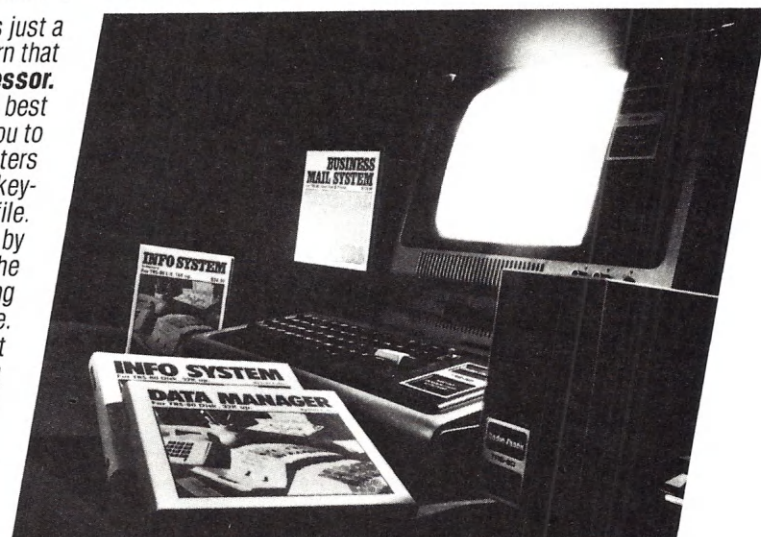
**DATA MANAGER** enables the user to create and maintain up to 5 "key" sort files for quick access of data. A utility program is provided to calculate the number of records possible since the amount of records you can maintain is dependent on a number of variables. This program also supports the upper/lower case modification, and printouts can be programmed to almost any format and sent to line or serial printer.

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After data entry, BMS automatically sorts the data by zip code and alphabetical order within the zip code. The program tells you when and which data disk to insert, expanding your files automatically until you've reached 300 disks. Data is input directly onto formatted screen display with the option to use Company Name/Attention instead of Last Name/First Name. Three numeric and one alpha code fields are provided to help you use the search and printout mode. **BUSINESS MAIL SYSTEM** allows you to



program the number and spacing of your labels.

With more features than can be described here, this high-powered program sells for \$125.00.

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**CHECKBOOK II** by Alan Meyers is the finest program of its kind yet published. With superb graphic screen displays, it does everything necessary to keep your checkbook balanced. Data is input directly into a five-column screen display with a field for alpha or numeric codes. Editing is done easily for changes in any or all columns. **CHECKBOOK II** will accurately balance and reconcile your checkbook, handling balances up to \$1,000,000. Your balance brought forward is always in memory. Outstanding checks are listed and easily saved. You can also search for an entry by any field except amount, and all checks with matching entries will be displayed and totaled. A numeric sort routine is included. Screen prints can be made to a line printer from almost any point in the program. In addition, the 32-48K version can write files to disk.

This, and the 16K version, are included on the same tape. For \$18.50, **CHECKBOOK II** is the bottom line in personal checkbook



programs. A disk version of this program is available for \$28.50.

**BUDGET II** (not yet released) by Alan Meyers, takes off where **CHECKBOOK II** ends. Written exclusively for either disk or tape based computers, this program enables the user to set up 20 account names with four character codes for each, that correspond to the codes used in **Checkbook II**. Each account can be tagged income or expense and whether it is fixed or not. Set your monthly budget and balance it. Disperse your cash account over the other accounts. **Checkbook II** data is brought in and summarized by account and compared to amount budgeted. Year-to-date totals are included in monthly summary. Year Summary gives monthly and year totals for each account at a glance. Forecast feature enables user to enter rate of inflation and income increase to see financial standing after 12 months. Review enables user to go back and look at months previously summarized. Flashy graphics and much more. For 16K and 32K tape, **BUDGET II** sells for \$24.50. For 32K up disk, \$34.50. If you have **CHECKBOOK II**, you will want this program.

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# Expand Your H8

*Expand your Heath H8, use it in the darkroom . . . or both.*

Larry Spani  
William Seely  
Syntex Data  
PO Box 24  
Monmouth OR 97361

If your H8 motherboard is full and there are additional boards you have your eye on, then read on.

We purchased our H8 system in December 1977 and quickly filled up all of the available slots, including the CPU board,

disk controller board, two serial boards and four 8K memory boards. The 16K board was not yet available (we weren't even aware that they had one planned), but by the time it was available, we were sorry we did not have the foresight to see it coming.

This brought us to the problem at hand: only 32K of memory and no room for expansion. One alternative would have been to replace three of the 8K boards

with 16K boards. This would have been both costly and left us with three less-than-useless 8K boards. Expanding the motherboard seemed a more logical approach.

We checked with the Heath computer technicians and found there were no plans in the works for expanding the H8 and probably never would be. One of the popular board manufacturers had also mentioned the possibility of an expansion board for the H8, but after writing to them we found that they, too, had no immediate plans.

If we wanted this expansion, we would have to do it ourselves; so we did. For approximately \$180, we designed our own expansion interface, and we are pleased with the results. If you are in a similar situation,

or if you just want the option of having the room for future board releases, then this article is for you.

## Description

The expansion interface consists of a printed circuit board, expansion cabinet and an interconnecting cable (Photo 1). The expansion unit was designed primarily to accommodate memory boards (8K and/or 16K) only. When you are finished, you can move memory from the H8 to the expansion unit with ample room in the H8 for all other boards. Because of this, we found that it was not necessary to design the expansion PC board to accommodate all Heath boards. Due to their variety, this would have been much more involved.

We strongly suggest that you

## CABINET

Refer to your H8 assembly manual. Order the items shown in the Parts List under Chassis Assembly with the exception of the following:

### ELECTRONIC COMPONENTS

### SHEET METAL PARTS

### PRINTED MATERIAL

### MISCELLANEOUS

Speaker  
Circuit board mounting bracket (2)  
Circuit board support clamp  
Do not order any of these items  
PCB connectors (2)  
Nut Starter  
IC Lifter  
Solder Wick  
Window  
3-Ring Binder  
Set of 5 Tabs  
System Software

## PC BOARD

### Parts Needed

(1) 6" x 6" double sided copper board  
(2) 25-pin connector (Heath P/N 432-947)  
(2) 25-pin 90 degree header strips  
(3) 20-pin IC sockets  
(3) 74LS241  
(1) +5 Volt regulator (7805)  
(1) 2.2 uF tantalum capacitor (20 V)  
(1) .01 uF capacitor (100 V)  
(3) 1.2k Ohm 1/4 Watt resistors (10%)

## MISCELLANEOUS

### Parts Needed

2 1/2' # 14 wire pair  
2-pin Molex Connector  
18" 50-conductor ribbon cable  
2 25-hole connector shells (Heath P/N 432-948)  
50 spring clips (Heath P/N 432-866)

Table 1. Parts list.

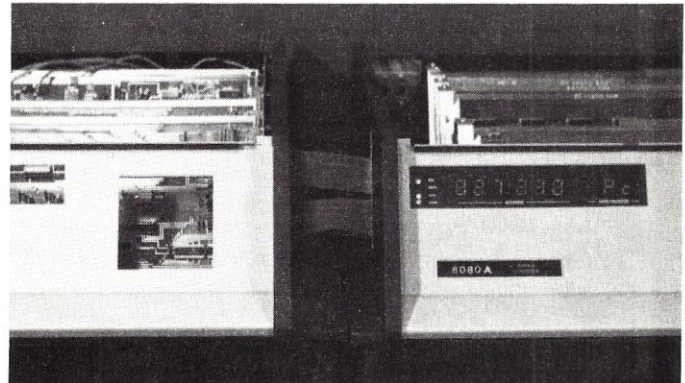


Photo 1. The interconnecting cable tying the two units into one.





Photo 2. H8 system with expansion unit.

read through the entire article and assess your situation before proceeding with any one part of this project.

The cabinet consists almost totally of Heath parts, for several reasons. The most prominent is cost. After pricing an appropriate enclosure and power supply, we found that those two items alone were equal to the cost of a complete H8 in parts, minus the CPU, front panel boards and a few other miscellaneous parts. There were also the problems of design (critical) and appearance. By sticking with the H8, we were able to solve all of those problems with a minimum of effort and cash.

A complete list referencing all needed parts is shown in Table 1. You may already have some of the items; you might purchase the others locally at a reduced cost, but be careful not to compromise quality for a few cents. If you do not have a price list of the parts for the H8, write or call Heath for one.

The double-sided printed circuit board is 6×6 inches. This board costs approximately \$30 to make, but it may be less for you if you already have developing and etching materials.

The cabinet will take most of the time needed to complete this project, as there are modifications to make in addition to assembling the cabinet.

#### Circuit Description

The circuit is a concise buffering unit composed of three non-inverting octal buffer/line drive ICs (74LS241). Two of the ICs are

used to buffer the 16 address lines, and the remaining IC buffers the memory write, I/O write, memory read, I/O read, phase 02 clock, reset and M1 (see Fig. 1).

Keep in mind that the 50-pin bus begins its count with 0, not 1. References to ICs will be given with the pin IN number first, followed by the corresponding pin OUT number, using the format IC3 (4-16).

IC1 and IC2 buffer the address lines as the signals move across the board. The address lines are buffered as shown in Table 2. If you use wire wrap rather than a printed circuit board, A0-A7 may be accommodated by one IC, and A8-A15 by the other. This will reduce the amount of wire crossover.

IC3 buffers the remaining signals as shown in Table 3. All other lines are unbuffered and are either carried by the foil pattern or by jumper.

The remaining pins are common on all three ICs and are assigned as shown in Table 4. The H8 and the expansion unit each have three voltage supplies. While the +8 volt supplies are connected by a #14 wire pair (described later), the remaining two supplies (+18 and -18) are interconnected between the two units via the foil pattern on the PC board.

#### The PC Board

The PC board (Photo 2) is relatively easy to make. The patterns for each side of the board are shown in Fig. 2. There are numerous books and articles to aid you in making PC boards.

|     |             |                                 |
|-----|-------------|---------------------------------|
| A0  | through A3  | IC2,(11-9),(13-7),(15-5),(17-3) |
| A4  | through A7  | IC1,(11-9),(13-7),(15-5),(17-3) |
| A8  | through A11 | IC1,(2-18),(4-16),(6-14),(8-12) |
| A12 | through A15 | IC2,(2-18),(4-16),(6-14),(8-12) |

Table 2.

|        |          |        |              |
|--------|----------|--------|--------------|
| (17-3) | RESET    | (15-5) | MEMORY READ  |
| (13-7) | I/O READ | (11-9) | MEMORY WRITE |
| (2-18) | PHASE 02 | (4-16) | I/O WRITE    |
| (8-12) | M1       | (6-14) | NOT USED     |

Table 3.

Once the PC board is etched and drilled, test all of the patterns on the board for continuity. It is much easier to correct a foil pattern problem now than later. Once you are sure the board is sound, the parts can be added.

Solder the three IC sockets into place. Next, insert and solder in the two Heath connector shells (P/N 432-947) at S1. Then insert the two 25-pin 90-degree header strips into S2 and solder those into place. Connect jumpers in the locations shown in Table 5.

Solder in a .01 uF capacitor at C2 and a 2.2 uF tantalum capacitor at C1. Install 1.2k Ohm resistors at R1, R2 and R3. Install the 7805, +5 volt regulator into its location at the high end of S1. Jumper remaining holes

in the board to the other side by inserting small lengths of wire through the board and soldering on both sides. Cut off all excess lead lengths. Recheck your work for poor solder connections, solder bridges, etc. A continuity check ensures proper installation of all parts. Insert the three 74LS241s into their sockets, and be sure pin 1 is in the proper place. This completes the PC board.

#### The Enclosure

Once you have all of the parts, put the expansion cabinet together using your H8 assembly manual for guidance. Three modifications must be made. Two involve wiring changes, and the third is a modification in the cabinet.

Since the H8 and the expan-

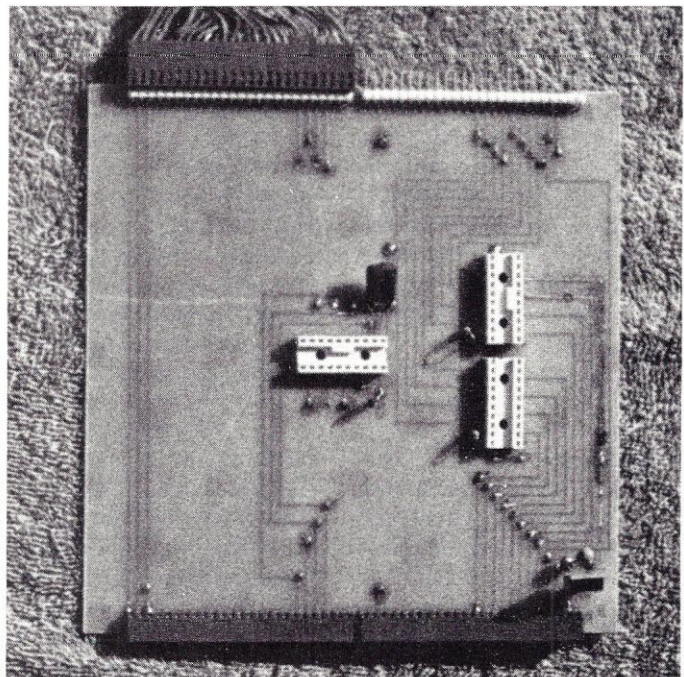


Photo 3. PC board for expansion unit.



Pin 10 is grounded and is tied to ground.  
 Pin 20 is connected to the +5 volt supply.  
 Pin 1 is an inverting control gate used to control the operation of four of the internal buffering circuits in each IC. This pin is tied to ground.  
 Pin 19 is a non-inverting control gate used to activate the remaining four internal buffering circuits in each IC. This pin is tied to the +5 volts at Pin 20 through a 1.2k Ohm resistor.

Table 4.

|                |    |               |
|----------------|----|---------------|
| (A) IC3 PIN 18 | to | (A) S2 PIN 22 |
| (W) IC3 PIN 16 | to | (W) S2 PIN 21 |
| (M) IC3 PIN 12 | to | (M) S2 PIN 19 |
| (R) S1 PIN 20  | to | (R) S2 PIN 20 |
| (D) S1 PIN 27  | to | (D) S2 PIN 27 |
| (P) S1 PIN 47  | to | (P) S2 PIN 47 |

Table 5.

sion unit must have power applied at the same time, it will be necessary to change the ac power switch wiring as follows (these steps follow the assembly instructions in your H8 manual; also refer to Fig. 3):

Do not connect a wire between lug 1 of the power switch and lug 2 of the fuseholder.

Do not connect the black line cord lead to lug 1 of the ac socket; instead, connect it directly to lug 1 of the power switch.

Do connect a wire between lug 2 of the power switch and lug 1 of the fuseholder.

Later in the assembly manual you are instructed to connect a lead from one of the switches located in the ac shield to lug 2 of the power switch; instead, connect this lead directly to lug 2 of the fuseholder.

When the project is complete, plug the H8 directly into the ac socket of the expansion unit, and the H8 power switch must be in the on position permanently. When you turn the expansion unit on, both units will have power applied at precisely the same moment.

The other wiring modification involves tying the two units' +8 volt power supplies together for consistency in operation. To do this, use a #14 wire pair to connect the terminals of the 77,000 uF capacitors of each unit (+ to +, - to -). Two and one-half feet of wire will be sufficient to reach between the two capacitors using the existing cable openings in the rear of each unit. We also put a Molex con-

ductor in the middle of the wire pair for ease of disconnection of the two units if it ever becomes necessary.

The third modification involves cutting two slotted openings — one in the right side panel of the expansion unit and the other in the left side panel of the H8. The interconnecting cable will pass through these openings. Each slot is directly in line with P3 of the motherboard and has the same angle. It will be necessary to remove all boards in the H8 to do this, and the motherboard in the expansion unit must not be in place.

Drill two holes in each of the two side panels. The top hole is measured 1 inch down from the top and 4½ inches in from the front edge of the side panel (refer to Fig. 4). The second hole is both 4½ inches down from the top and 4½ inches in from the front edge. Use a small bit to drill pilot holes, then redrill the holes with a ¼ inch bit. Once this is done, use a straight edge to draw two lines between the outer edges of the holes. Use a coping saw with a fine-toothed saw blade to cut out the area between the holes. The side panels are made of plastic and cut easily. If necessary, use a fine file to even any rough spots when you are finished cutting.

The reason for cutting these slots is that the interconnecting cable must not be over 18 inches long, or buffering problems will occur. If you do not wish to cut into the side panels, you can go over the top of them, but this still means you have to niche

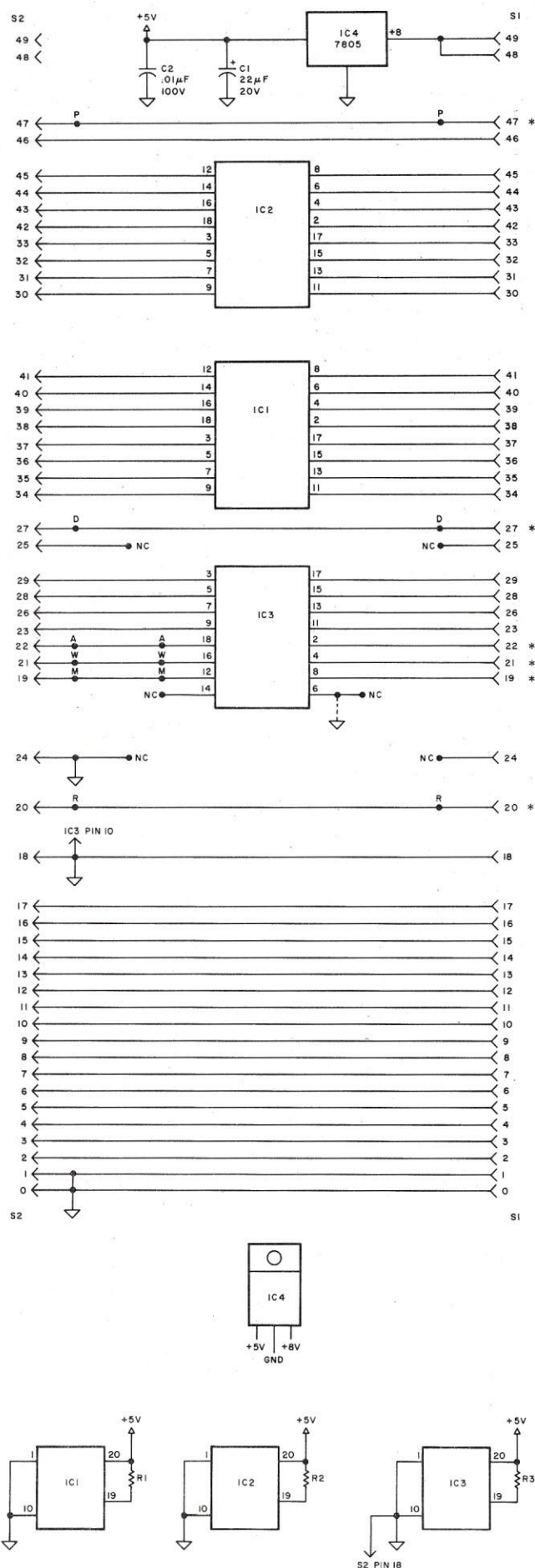
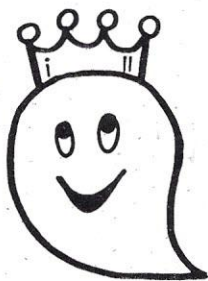


Fig. 1. Schematic for PC board.



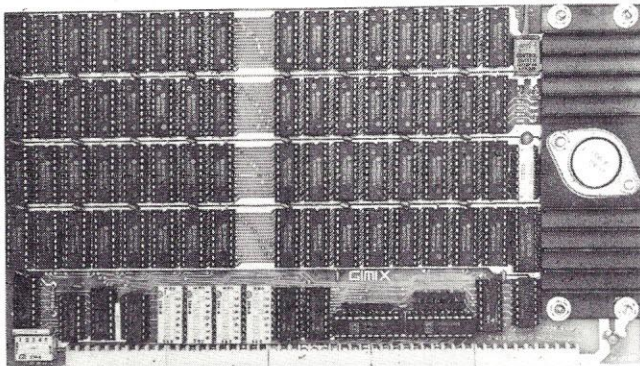


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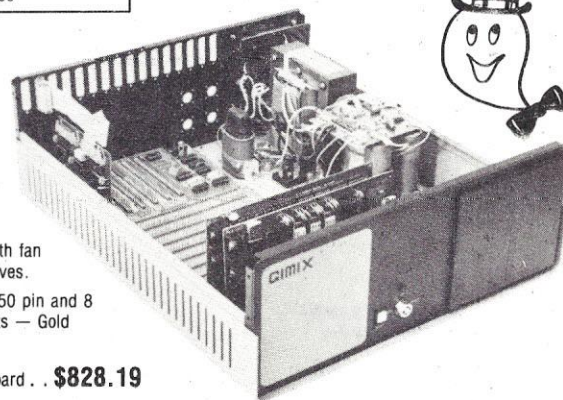
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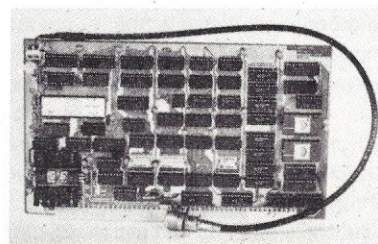
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out the tops of the panels to allow the covers to fit. Unfortunately, the cable is not long enough to use the existing cable openings in the rear of each unit. We found the slotted-openings technique best, but whatever method you choose is fine, as long as the cable length does not exceed the maximum 18 inches.

Next, cut a 50-conductor ribbon cable to the appropriate length; 14 inches is plenty if you have cut the slots. You can separate the cable into two 25-wire cables for ease of handling. On one end, solder a spring clip to each of the 50 wires. Then fasten the wires into two 25-pin female connector shells. On the other end, separate the individual wires about 1½ inches, and

strip the insulation back on each wire *no more* than 1/8 inch.

Position the expansion unit motherboard with the foil side up and solder a wire of the cable to each of the 50 pins at P3. No bare wire can be exposed; do not melt the insulation. Slide the ribbon cable through the slotted opening in the expansion unit and fasten the motherboard into place.

If you choose not to cut the slots in the panels, put two 25-pin female connector shells on this end of the cable also. You can then slide these connectors onto P3 of the expansion unit motherboard after it is fastened into place. If you go this route, don't forget to order the extra connector shells and spring clips. With that, the en-

closure is complete.

### Installation

Installation is simple. Make sure the #14 wire pair that ties the two +8 volt supplies is connected. Plug the H8 into the ac socket of the expansion unit and place the H8 power switch in the on position, where it will remain permanently. Make sure the expansion unit is off.

Insert the expansion PC board onto P3 of the H8 motherboard. Move the lowest addressed memory board onto a slot of the expansion unit motherboard. One end of the interconnecting cable should already be connected to the expansion unit. Route the cable through both slots and insert the connector shell end onto the

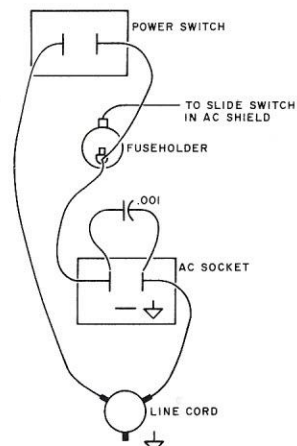


Fig. 3. Wiring aid for ac modification in expansion unit.

header strips of the expansion PC board. Do not twist the cable around.

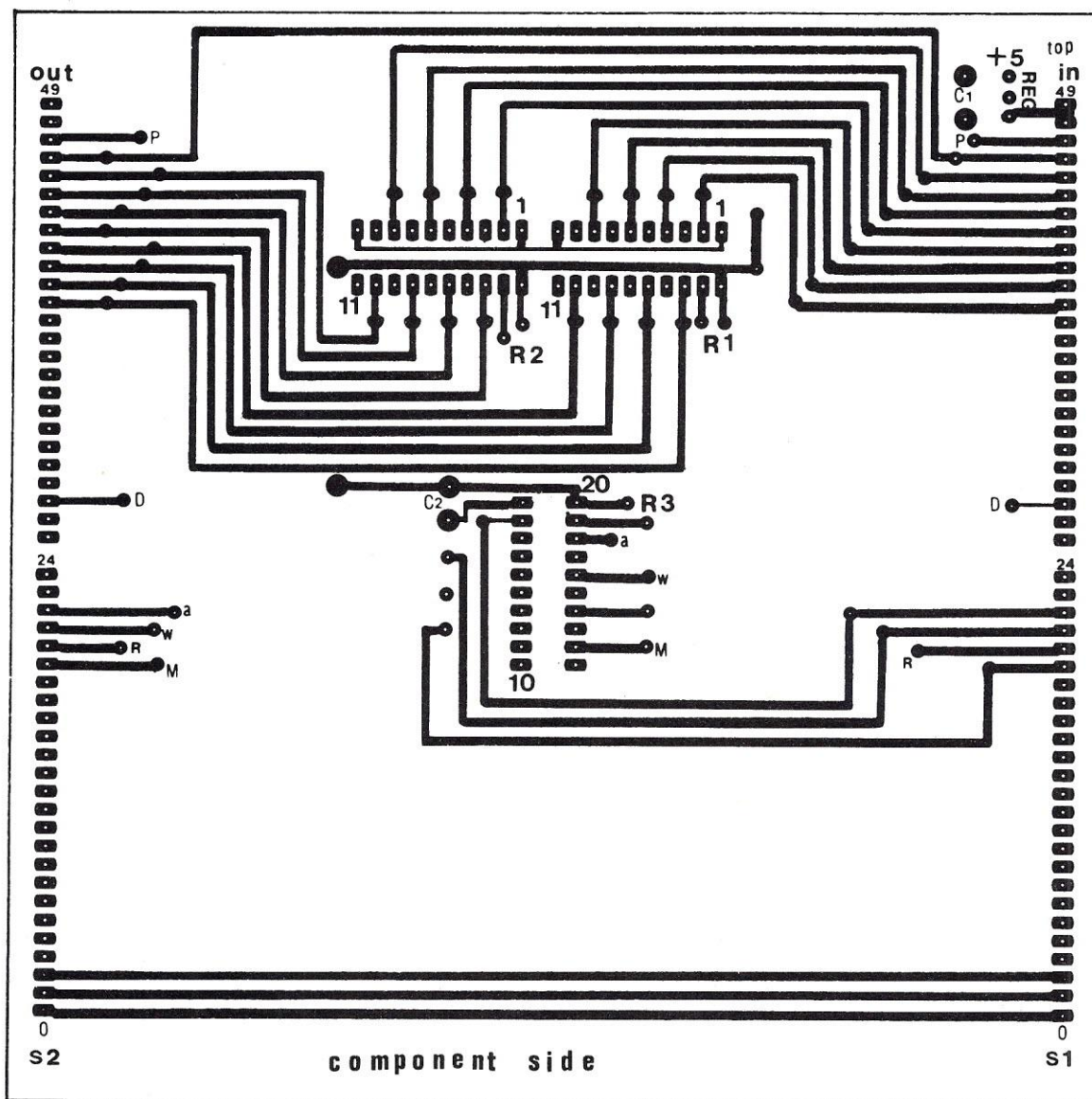
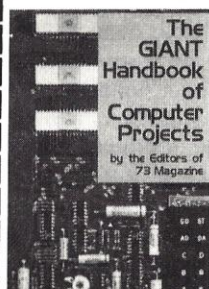


Fig. 2a. Component (top) side of PC board layout.

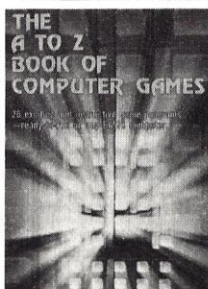


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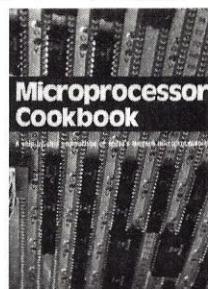
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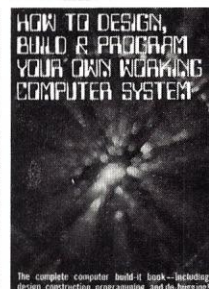
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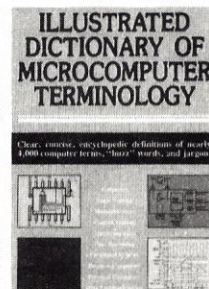
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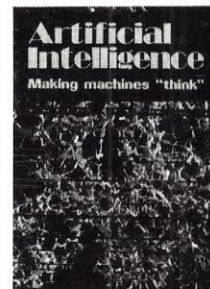
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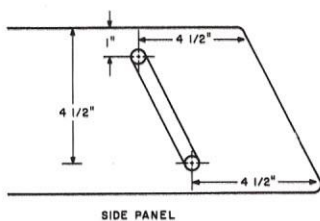


Fig. 4. Mechanical diagram for slotted openings in side panels.

Turn the expansion unit on. If the ION, RUN and PWR LEDs come on and you hear the familiar beep, the board is working and the two units are communicating. This is the reason you use the lowest-addressed memory board for the test, since the computer cannot access any memory if it cannot communicate with the first 8K board.

If any one of the three LEDs do not light, a problem exists. Turn the expansion unit off and remove the expansion PC board from the H8. The relatively simple design of this board should make the problem easy to locate. Check for solder bridges and unsoldered connections and test all parts and connections for continuity. If everything is OK, you may have a bad 74LS241. Locate the problem, then check the fuse in each unit before re-testing. One of them may have blown during the initial test.

As a final test, bootstrap the system and run a commonly used BASIC program that resides on disk. This will fully test the communications between the two units. We experienced

no problems at all and were running the system with a full 56K before we knew it.

### Conclusion

Our unit has been in operation for months. Now we wonder how we got along with only 32K.

To complete the expansion unit, we put a translucent red cover over the rectangular hole (such as is on the H8) and an opaque black cover over the keypad hole. We are also planning to add an LED digital clock to be located behind the red cover to be used for timings.

Overall, we think the Heath H8 system is excellent. Heath supports its equipment. The technicians at the Heath computer lab can provide us with sufficient assistance over the

telephone to correct the few hardware problems we have had. The assembly documentation for all kits is outstanding, as are the user's manuals.

Heath has done well in supplying software, considering how few companies provide any outside support for this system. However, Lifeboat Associates (Suite 505, 2248 Broadway, New York NY 10024) recently released a version of CP/M for the Heath. Apparently this versatile operating system will support high-level language compilers. Lifeboat has already released a version of COBOL to operate with their CP/M.

The Heath System is a pleasure to own, and with the addition of the expansion unit, you can make it more so. ■

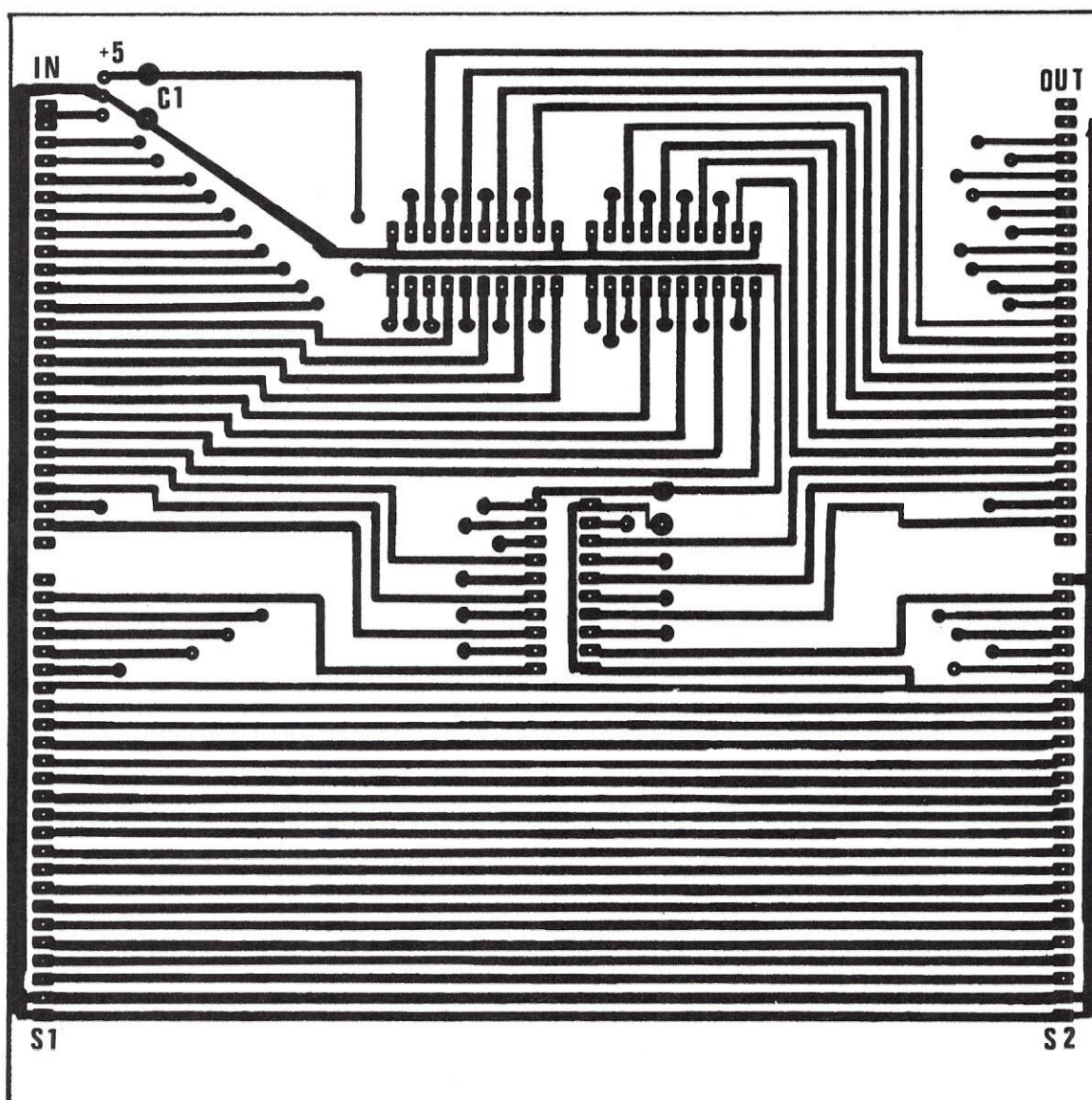
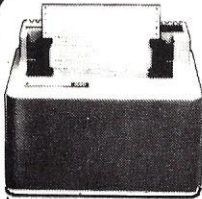


Fig. 2b. Bottom side of PC board layout.





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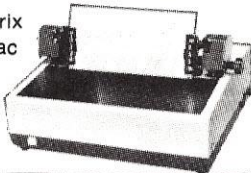
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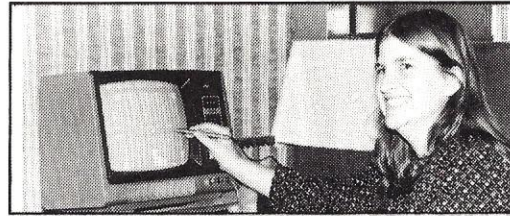
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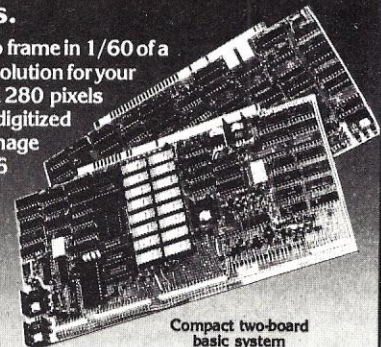
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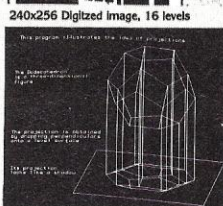
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# The New HP-41C

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*Is it a calculator or a computer? Read on and see what you think.*

---

Gregory R. Glau  
PO Box 1627  
Prescott AZ 86302

**W**hat's a review of a calculator doing in a computer magazine?

While the new Hewlett-Packard HP-41C is a hand-held calculator, it shares many of the same features of its larger brother, the microcomputer. In fact, you might say the new HP-41C is a micro/mini/macro hand-held computer!

## Features

The HP-41C (\$295) can handle all the operations you'd expect in a small calculator (sine, cosine, tangent, radians, pi, square root), but it can also use and display alphanumeric strings. You can store and recall strings and even compare them.

It is fully programmable and has continuous memory, which means your program information and data are saved when the calculator is turned off. This allows you to use the alphanumeric display capability to ask for input (SALES ?) and to label output (PROFIT = %). This hand-held unit, like a microcomputer, can talk back to you. The HP-41C will produce ten different beep tones under software control.

The HP-41C also continuously stores three catalogs of information. The first lists by name the programs you have stored in memory, so you always know exactly what programs of your own are available to you at any one time. The second catalog lists the programs contained in any application module you have plugged into the unit. This catalog will read out 0 when you don't have a module working with the unit. The third

catalog lists all the operations the HP-41C can perform . . . all 130 of them.

The calculator also works with a list of error messages, which helps in debugging your programs. You can step through a program line-by-line in either direction. The calculator also has a weak-battery indicator (the four "N" batteries will last about a year).

The HP-41C automatically inserts blank program lines into your program as you write it, similar to writing on a small computer in BASIC and skipping lines by tens to leave room for more program lines. If you've left out any lines, you can insert them into the program; the rest of your program will be bumped down the appropriate number of spaces. Likewise, when you've put extra lines into the program, you can delete them, and the rest of the program memory will be moved up.

Besides this full editing control, once you've completed your program, you can execute a PACK function, which removes all the extra lines and makes the program run faster.

## Space-Saving Techniques

The HP-41C doesn't use a GOSUB function; instead, you use an execute command, for example, XEQ 30. Then, at whatever line your subroutine starts, you write LBL 30 (label 30).

So, as your program grows (and they all seem to), the line starting your subroutine might be bumped down over and over until, for instance, it ends up at line 45. Line 45 would then read 45 LBL 30. When the subroutine is called for (XEQ 30), it doesn't go to line 30, but to LBL 30. Your programs can grow without having to change all your sub-

routine numbers and locations.

Using the HP-41C, you assign a name to every program (HEAT, NET, SALES). At the end of that program, you insert an END statement to let the unit know that the program ends at that point in memory. You can then follow in memory with another program (assuming you have the memory space) headed by the program name.

You can then call up any program by name and run it. Contrast this to the old programmable calculator technology that allowed you to input only one program at a time into the unit. Now, you can have as many programs in memory as you have room for and execute them individually.

Although the programs are isolated from each other, the subroutines are not. This means you can access any subroutine from any program.

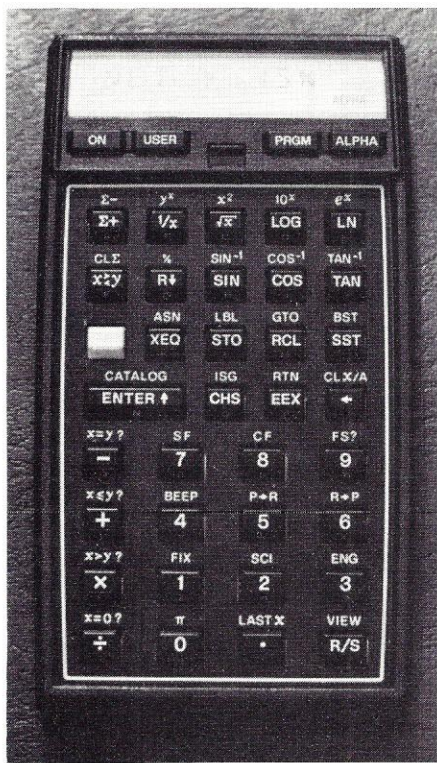
You can imagine the extra space and time you gain because of this feature. You could, for example, store five financial programs you regularly use. While they all might handle a different task, perhaps they'd use a common subroutine, which you could place in any of the programs and access and execute it from any of the others.

If one of your programs does go outside of itself to get to a subroutine, it might take a second or two for it to search and find it. But the next time you run the program, the HP-41C will remember where that subroutine was and spend no time searching for it!

You can also isolate a subroutine inside a program (have your program search only in the current program for the subroutine). The HP-41C will execute up to six levels of subroutines.

Memory space and program space are





The HP-41C—more than a calculator.

shared. When it's first turned on, the calculator has 17 registers for data (or alphanumeric) storage and 46 registers for program information (which can handle up to 300 lines). You can change this ratio at any time (even while you're programming). There also are additional plug-in modules available, so you could—with four modules hooked up to the HP-41C—end up with five times the original capacity for storage and/or program memory.

To use the alphanumeric capability of the HP-41C, you have to push the ALPHA switch on the calculator. This allows you to talk to the unit by using the letters (which are also printed on the keyboard) of the alphabet.

You can also use the ALPHA mode to execute functions not listed on the keyboard. The standard keyboard shows 58 functions, but the HP-41C can perform 130 different functions.

To make the calculator stop briefly in a running program—to display data or the result of some calculation—you must execute this function, since there's no PAUSE function on the keyboard.

First, you must push the XEQ key (execute). Then, you must push the ALPHA key to allow you to talk to the HP-41C using the letters of the alphabet. Then, key in PSE (the code for PAUSE). Finally, hit the ALPHA key once again to remove the calculator from ALPHA mode.

All this sounds much more complicated than it really is. If you were to put a PAUSE

command into a program, your keystrokes would be XEQ ALPHA PSE ALPHA—not really complex at all. You can perform any function on the HP-41C by executing (XEQ) it.

Hewlett-Packard has carried this one step further by adding a user mode to the HP-41C. This allows you to reassign any calculator function to any key.

For example, you might want to replace a seldom used function (cosine) with another function (PAUSE, for instance). To do so you'd simply put the calculator into the user mode, push the COS key... and it would automatically put a PAUSE into your program. HP even gives you two overlays and some stickers to put on them so that you can keep track of user-assigned keys. It's convenient to be able to execute a function or operation with just a couple of keystrokes—better than keying in the function alphabetically. But I found that the user mode is most valuable during program execution.

For example, if you have five programs stored—HEAT, SOLAR, PROFIT, TIME and NET—and each performs a task you need to handle every day, the continuous memory of the HP-41C keeps your programs ready to go whenever you want them.

To run a program, you must push XEQ, then the ALPHA key, then key in the program name and then the ALPHA key again. While this example only requires a few keystrokes (XEQ, ALPHA, HEAT, ALPHA), if you run a program ten times—each time inputting different data—you would quickly wear out your key-pushing finger.

Hewlett-Packard has made it possible to assign a program to any key. Once you've assigned a program to a key (the same way you assigned PAUSE to the COS key), you can run things much faster. Instead of pushing, for example, XEQ, ALPHA, SOLAR, ALPHA to run the SOLAR program (eight keystrokes), you can simply push one key.

However, the function you "assign over" is not lost. If you assigned the HEAT program, for instance, to the 1/x key, the HEAT program will run when you push the 1/x key while the calculator is in the user mode (the USER switch has been pushed). But if you hit that USER switch again—to put the calculator back where you started—the 1/x function will again become available. And the HP-41C remembers your assigned keys while it's turned off!

So, in effect, you could completely customize the calculator to make instantly available those functions you use all the time. In short, you can design the calculator yourself!

#### Extras

Available options include a printer (\$350),

a card reader (\$195) to store program and data information and extra memory modules (\$45). Hewlett-Packard is working on a wand to plug into the HP-41C to read printed bar codes directly into program memory.

Although a limited amount of software—most of it from the older HP67/97 software—is available, more is on the way... designed just for the special capabilities of the HP-41C, both in the form of application books (\$12.50) and plug-in modules (\$45). The new calculator comes with a detailed instruction book (267 pages).

#### Conclusion

Like everything else, the HP-41C is limited. You only get one readout at a time; while on a small computer you can fill the video screen with data. It also lacks the speed of a microcomputer.

One salesman told me that the HP-41C, with four memory modules plugged in, had about 4K of usable capacity. Not bad for something you can hold in your hand and carry home with you, out on the job or on a plane trip. It sure beats lugging around a bulky microcomputer.

It won't do everything a small computer will—and it wasn't intended to—but it comes close. ■

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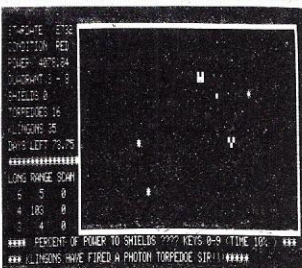
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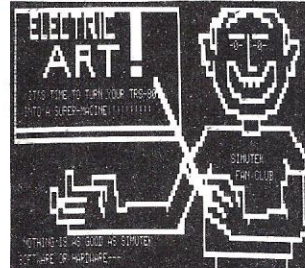
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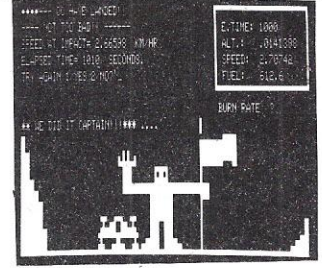
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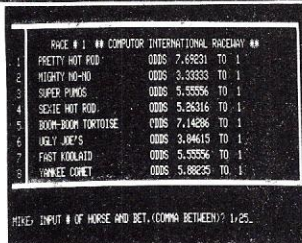
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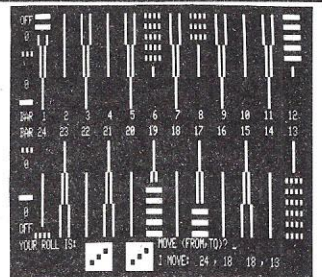
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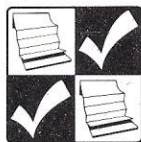
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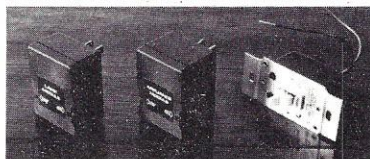
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# Data Communication Error Measurement

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*This 8080 machine-language program checks for errors in data-transmission systems.*

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Terry A. Conboy  
1231 Crestview Drive  
San Carlos CA 94070

One of the more fascinating aspects of computing is data communications. Extensive networks link together commercial computers with satellite processors, remote terminals and even other large machines. The promise of electronic mail cannot be realized without an intricate web of data communication channels.

Computer hobbyists are only just beginning to see the potential of communication with the machines of other enthusiasts for bulletin boards, computer game competition, expanded processing capabilities and other imaginative uses.

Common to all users of data communication, whether commercial or hobbyist, is the need to maintain the reliability of the transmission channels and data communications equipment. Developers of modems must be able to verify the performance of their designs in some quantitative way. The technique presented here will allow the hobby computer user to make the measurements necessary to perform both of these functions.

There is a large variety of commercial test equipment available to check data communications links. Almost all of the units carry price tags larger than the total investment by an average hobbyist. Fortunately, there is a relatively simple way to generate sequences of bits

that can be inspected by a digital circuit or computer to ferret out errors caused by noise, distortion, interference or other mischief in the transmission path.

My first thought was to build a simple version of a stand-alone test box with the capability of sending and checking a stream of bits for errors in transmission. Having almost completed the design of this error-rate test box, I figured that it would be worthwhile to parallel the development of the hardware with a program for my computer system to perform the same function. It didn't take long to realize that the software solution was far easier to accomplish, and I soon completely forgot about the hardware approach.

## Error-Checking Methods

Several approaches could be taken to measure the error performance of a data communications system. Use of a cyclic redundancy check (CRC) is not specific enough. It lets you know that there is an error in a block transmission, but there could easily be more than one.

A parity bit for each character could be generated and inspected. This has a few problems. Multiple errors can easily cancel out. If the transmission channel is really in bad shape, such as is often the case on HF radio circuits, characters may be missed entirely, along with the parity bit that is supposed to check them. Certain codes, such as the five-level code (Mur-

ray), do not provide for parity bits at all.

The "quick brown fox" that has been jumping over lazy dogs for many decades could be used to spot erroneous characters. Again, multiple errors per character could not be easily detected. It would also seem that synchronization at the receiving end could be a problem with the fox test sequence.

Alternating characters containing reversing bit patterns, such as the R-Y test used in five level, would allow bit error checking, but could fail to pinpoint errors that occur when other characters are transmitted.

By far the most common method, and the one with the fewest negative points, is the use of a *pseudorandom binary sequence (PRBS)*. The PRBS can be generated and checked in hardware or software. It allows an accurate count of errors at the receiving end. Because of the variety of patterns of bits created, any sensitivity of the data communication equipment to particular patterns will be stimulated.

## Generating a PRBS

The first item to consider is the method used to generate a PRBS. The usual approach is to use a long shift register with multiple feedback taps. The feedback taps are added modulo 2, and the result is stuffed back into the input of the shift register. This is shown for a four-stage shift register in Fig. 1.

There is no mystery to modulo

2 arithmetic. The result of a modulo 2 addition is obtained by adding the numbers in the normal fashion and then dividing by 2. The remainder is the sum mod 2. In a binary numbering system, this is really a snap. Just add all of the single bits (one-digit binary numbers) and ignore the carry. For adding only two bits, this is identical to the exclusive OR function. Still another way of generating the mod 2 sum is to take the odd parity of the bits to be added. If there are an odd number of 1s, the result is equal to 1. If there are an even number of 1s, the answer is 0.

For the four-stage shift register shown, there are fifteen different states. You might expect there would be sixteen, which is the number of different combinations of four bits. Unfortunately, when all of the registers contain 0, the PRBS generator will latch up, since the feedback will always be 0. Whether the sequence is generated in software or hardware, this all 0 condition must be checked for to avoid initialization problems.

In general, the number of states that can occur until the sequence repeats is  $(2^n - 1)$ , if the proper taps are chosen for the (n) stages. Table 1 indicates the positions of the taps and the sequence length for shift registers up to sixteen stages. There are other combinations of taps that will produce maximal-length sequences, but those given involve the minimum number of taps. "Pseudorandom Sequences and Arrays" (F. Jessie



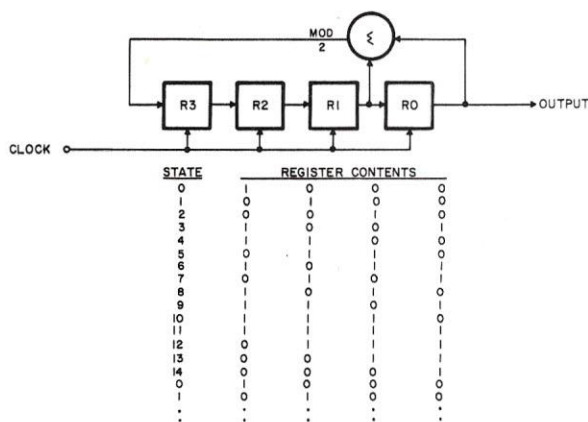


Fig. 1. A four-stage pseudorandom binary sequence generator. The contents of the registers change state on one edge of the clock. In this case, the modulo 2 summer could be replaced by an exclusive OR gate.

MacWilliams and Neil J.A. Sloane, *Proceedings of the IEEE*, December 1976, p. 1715) gives a complete discussion of PRBS generators and an extensive bibliography.

#### Checking for Errors

Although the sequences generated by the feedback shift registers can be extremely long, they are also very predictable. This is what makes them useful for error checking. My first reaction to the concept made me wonder if it was necessary for the error detection logic to scan the entire sequence before the detector could "find its place."

Fortunately, this isn't the case. The detector circuit must only receive a number of correct bits equal to the number of stages in the PRBS generator before it can predict exactly which binary value the next bit should be. If there is a disagreement, the new bit is in error.

An error detector for a PRBS generated by a four-bit shift register is shown in Fig. 2. The error detector must have the same number of stages as the generator. It must also have the same configuration of feedback taps. The difference between the generator and the error detector is that there is no actual feedback in the detector. The modulo 2 sum of the feedback taps is merely compared to the bit, which will be shifted into the register next. This should be the same bit that was shifted into the generator shift register several time states previously.

The exclusive OR gate functions as a data comparator. If the incoming bit differs from the sum of the taps, the XOR gate output will go to a 1, indicating an error.

Remember that the detector shift register must be full of correct bits before an erroneous bit can be detected. Complications arise when the bad bit is shifted into the shift register on the following clock pulses. Eventually this bit gets to the taps and causes an incorrect sum to be formed. The result is that the new incoming bit is declared to be wrong even though it is actually right. For isolated bit errors, there will be an error noted for each tap, plus the one for the first time it is found. In the case of the four-stage detector in Fig. 2, there will be three errors counted for each bad bit received.

This becomes further complicated if the errors occur in bursts. You can imagine what will happen if another error comes along just at the same time a previous error is in position at the taps. Two wrongs seem to make a right. In practice this will cause the error total to be slightly smaller than you would have expected. Unless the data communications channel that you are monitoring is really rotten, the underestimate of errors won't be large.

#### Use in Asynchronous Systems

What we have been considering is an oversimplified data transmission system. There has

been no mention of the source of the clocks for the two shift registers. Obviously, the clock at the transmitting end sets the baud rate for the system. The clock at the receiving end must be magically regenerated from the transitions of the incoming bits or must be sent in some other devious fashion from the transmitting end, perhaps by a separate channel. Regeneration of the received clock is a normal function in a synchronous data transmission arrangement, but not many hobbyists are using synchronous systems. For that reason, we'll restrict our attention to asynchronous schemes.

At first glance, using an asynchronous transmission system might seem to present some problems. What do you do about the required start bit, parity bit (if used) and stop bit(s)? Fortunately, normal methods of sending serial data take care of all of these details. A device such as a UART (universal asynchronous receiver-transmitter) is typically used in a serial I/O

port.

At the transmitting end, the desired number of the least significant bits of the PRBS shift register are parallel loaded into the UART for transmission. The UART handles the addition of the overhead bits required for transmission. At the receiving end, it takes care of character-by-character synchronization and removes all of the added bits. The parallel output of the UART is then shifted into the error detector one bit at a time. This can be done at any convenient rate as long as it is fast enough to be completed before the next character arrives.

Put another way, we pretend that groups of bits from the PRBS make up the information bits of asynchronous characters. We end up sending the bit sequence a bunch at a time without mixing up the original order.

A note of caution is worth mentioning: even though the sequence of bits from the shift register at the sending end is

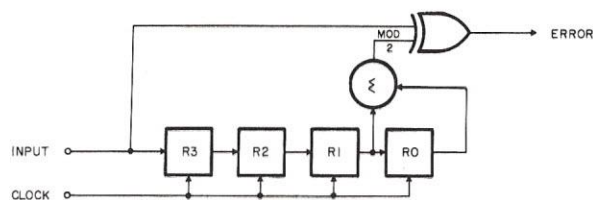


Fig. 2. A four-stage PRBS error-checking circuit. There is no actual feedback as in the generator. The modulo 2 sum of the taps is compared with the incoming bit by the exclusive OR gate. An output of 1 indicates an error. Here again, the summer could be an exclusive OR gate.

| Number of Stages | Feedback Taps On Registers | Sequence Length |
|------------------|----------------------------|-----------------|
| 2                | 1,0                        | 3               |
| 3                | 1,0                        | 7               |
| 4                | 1,0                        | 15              |
| 5                | 2,0                        | 31              |
| 6                | 1,0                        | 63              |
| 7                | 1,0                        | 127             |
| 8                | 6,5,1,0                    | 255             |
| 9                | 4,0                        | 511             |
| 10               | 3,0                        | 1023            |
| 11               | 2,0                        | 2047            |
| 12               | 7,4,3,0                    | 4095            |
| 13               | 4,3,1,0                    | 8191            |
| 14               | 12,11,1,0                  | 16383           |
| 15               | 1,0                        | 32767           |
| 16               | 5,3,2,0                    | 65535           |

Table 1. Required feedback taps and resulting pseudorandom binary sequence length for shift registers from two to 16 stages.

#### Program listing.

```

0000 C5      Save registers on stack
0001 D5      PUSH B
0002 E5      PUSH D
0003 F5      PUSH H
          PUSH PSW
          COMTST
          PUSH B
          PUSH D
          PUSH H
          PUSH PSW

```



pseudorandom, the stream of characters that results is not really random, as might be judged by certain mathematical standards. This isn't the best way to implement a random number generator for gambling purposes.

### Program Description

The error measurement program is written in 8080 machine language. I'm sure that with suitable cleverness, it could be done in BASIC, but the shift and rotate instructions of the processor are ideally suited to the generation and checking of the bit sequences. Why make it hard?

A 15-stage configuration was chosen for the PRBS generator and error detector. This provides a long sequence without creating a software mess. A 16-stage design would have required the simulation of two more taps and would have complicated the error-checking arrangement. The varied 16-bit manipulations in the 8080 instruction set simplify the program greatly.

A flowchart of the program appears in Fig. 3. There are three main sections in the program. The control section takes care

of initialization, reset of the error count and exit from the routine. The transmission section implements the PRBS shift register and sends the individual characters to the modem I/O port. The receiving section gets characters from the modem I/O port, shifts the bits through the error-checking shift register and keeps and finally outputs the total of any errors found.

By far the most confusing aspects of the program are the PRBS generator and the error-checking section. Both the transmit and receive shift registers' contents are kept in RAM between generation and checking of the bits in a character.

In the transmitting section of the program, the shift register contents are transferred to the HL register pair. There is a check for all 0s to avoid a latch-up state. The contents of the L register are then moved to the accumulator, and all but the two least significant bits are masked off. The parity flag is then checked. If the parity is odd, then the feedback is 1. To stuff the feedback into the shift register, the H register is ORed with 80 hex to set the most sig-

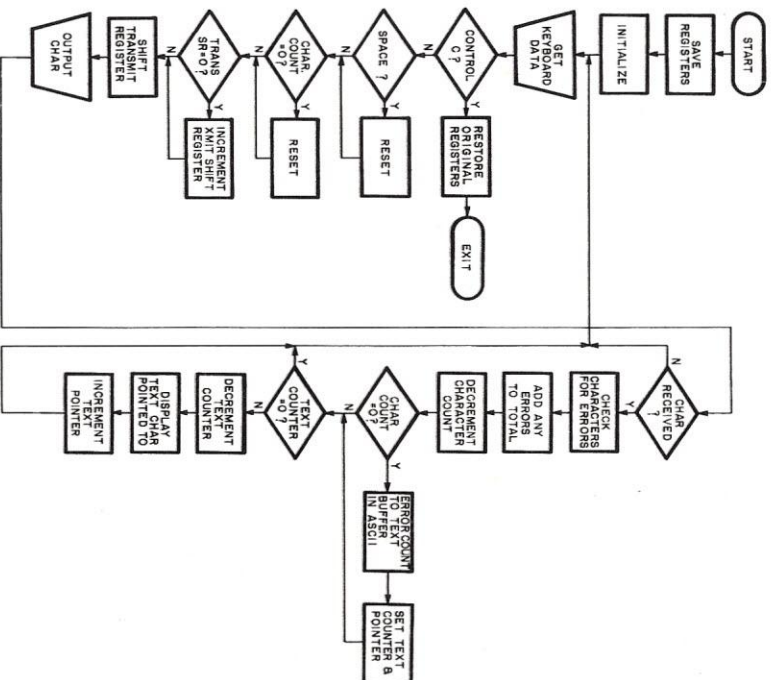


Fig. 3. The flowchart of the error-rate measurement program

After the feedback is added, the H and L registers are rotated (in the accumulator) through the carry bit. This permits the bit that falls out of the H register to

The contents of the HL register be moved into the L register. This calculation of feedback and shifting to the right is repeated once for each of the information bits to be sent in the character (7 for ASCII).

|      |    |    |    |            |                                  |
|------|----|----|----|------------|----------------------------------|
| 0004 | AF |    |    | XRA A      |                                  |
| 0005 | 32 | 05 | 01 | STA TXXCNT | Zero Text Counter                |
| 0008 | CD | D8 | 00 | CALL RESET |                                  |
| 000B | DB | 03 |    | IN KBSTAT  | Get Keyboard Status              |
| 000D | E6 | 02 |    | ANI 02H    | Bit 1 = Data Available           |
| 000F | CA | 25 | 00 | JZ CKCNT   | If no data, bypass decoding      |
| 0012 | DB | 02 |    | IN KBDATA  | Get Keyboard Data                |
| 0014 | E6 | 7F |    | ANI 7FH    | Ignore any Parity Bit            |
| 0016 | FE | 03 |    | CPI 03H    | Is it "CONTROL-C"?               |
| 0018 | C2 | 20 | 00 | JNZ CONT   | No, continue program             |
| 001B | F1 |    |    | POP PSW    | Yes, return registers            |
| 001C | E1 |    |    | POP H      |                                  |
| 001D | D1 |    |    | POP D      |                                  |
| 001E | C1 |    |    | POP B      |                                  |
| 001F | C9 |    |    | RET        | and exit...                      |
| 0020 | FE | 20 |    | CPI 20H    | Is it a "SPACE"?                 |
| 0022 | CC | D8 | 00 | CZ RESET   | Yes, reset Error & Char Counters |
| 0025 | 2A | 06 | 01 | LHLD CHCNT | Get Character Counter from RAM   |
| 0028 | 7C |    |    | MOV A,H    |                                  |
| 0029 | B5 |    |    | ORA L      | Is Counter zero?                 |
| 002A | CC | D8 | 00 | CZ RESET   | Yes, reset Error & Char Counters |
| 002D | 0E | 07 |    | MVI C,07H  | Set up no. of Information Bits   |
| 002F | 2A | 08 | 01 | LHLD TSR   | Get Transmit Shift Reg from RAM  |
| 0032 | 7C |    |    | MOV A,H    |                                  |
| 0033 | B5 |    |    | ORA L      | Shift Reg contents all zeroes?   |
| 0034 | C2 | 38 | 00 | JNZ OK     | No, do nothing                   |
| 0037 | 23 |    |    | INX H      | Yes, bump register to unlatch    |
| 0038 | 7D |    |    | MOV A,L    |                                  |
| 0039 | E6 | 03 |    | ANI 03H    |                                  |
| 003B | 7C |    |    | MOV A,H    | Select Feedback Taps             |
| 003C | EA | 41 | 00 | JPE FBZ    | If Parity Even, Feedback is zero |
| 003F | F6 | 80 |    | ORI 80H    | If Odd, set Feedback to one      |
| 0041 | 1F |    |    | RAR        | Shift Feedback into higher bits  |
| 0042 | 67 |    |    | MOV H,A    |                                  |
| 0043 | 7D |    |    | MOV A,L    | Transfers shift out via Carry    |
| 0044 | 1F |    |    | RAR        | Shift lower order bits           |
| 0045 | 6F |    |    | MOV L,A    |                                  |
| 0046 | 0D |    |    | DCR C      | Decrement Info Bit Counter       |
| 0047 | C2 | 38 | 00 | JNZ OK     | Loop until all bits shifted      |
| 004A | 22 | 08 | 01 | SHLD TSR   | Keep Shift Reg contents in RAM   |
| 004D | DB | 01 |    | IN MDSTAT  | Get Modem UART Transmit Status   |
| 004F | E6 |    |    | ANI 01H    | Bit 0 = Transmit Buffer Empty    |
| 0051 | CA | 4D | 00 | JZ CHSEND  | Wait until empty                 |
| 0054 | 7D |    |    | MOV A,L    | Get low order bits of Shift Reg  |
| 0055 | D3 | 00 |    | OUT MODEM  | Send the new Character formed    |
| 0057 | 0E | 07 |    | MVI C,07H  | Set up no. of information bits   |
| 0059 | 06 | 00 |    | MVI B,00H  | Clear Char Error Counter         |
| 005B | 2A | 0A | 01 | LHLD RSR   | Get Rcvr Shift Reg contents      |
| 005E | DB | 01 |    | IN MDSTAT  | Get Modem UART Receive Status    |
| 0060 | E6 | 02 |    | ANI 02H    | Bit 1 = Receive Data Available   |
| 0062 | CA | 0B | 00 | JZ CONTRL  | Go to pgm beginning if no char   |
| 0065 | DB | 00 |    | IN MODEM   | Get new Received Character       |
| 0067 | 00 |    |    | NOP        | Room to output the character     |
| 0068 | 00 |    |    | NOP        | to your front panel...           |
| 0069 | 0F |    |    | RRC        | Rotate LSB to MSB                |
| 006A | 57 |    |    | MOV D,A    | Save rotated character           |
| 006B | E6 | 80 |    | ANI 80H    | Mask off all but MSB             |
| 006D | 5F |    |    | MOV E,A    | Save incoming bit                |
| 006E | B4 |    |    | ORA H      | Combine w/MSD of Rcv Shift Reg   |
| 006F | 67 |    |    | MOV H,A    |                                  |
| 0070 | 7D |    |    | MOV A,L    | Get LSD of Rcv Shift Reg         |
| 0071 | E6 | 03 |    | ANI 03H    | Select Feedback Taps             |
| 0073 | B3 |    |    | ORA E      | Combine with incoming bit        |
| 0074 | EA | 7C | 00 | JPE GOOD   | If Parity even, Bit is correct   |
| 0077 | 3E | 01 |    | MVI A,01H  | If odd, set A to 01              |
| 0079 | 80 |    |    | ADD B      | and add to Char Error Count      |
| 007A | 27 |    |    | DAA        | in BCD                           |
| 007B | 47 |    |    | MOV B,A    |                                  |
| 007C | 7C |    |    | MOV A,H    |                                  |
| 007D | 1F |    |    | RAR        | Shift higher order bits          |
| 007E | 67 |    |    | MOV H,A    |                                  |
| 007F | 7D |    |    | MOV A,L    |                                  |
| 0080 | 1F |    |    | RAR        | Shift lower order bits           |
| 0081 | 6F |    |    | MOV L,A    |                                  |
| 0082 | 7A |    |    | MOV A,D    | Restore rotated Rcvd Character   |
| 0083 | 0D |    |    | DCR C      |                                  |
| 0084 | C2 | 69 | 00 | JNZ AGN    | Repeat until all bits checked    |
| 0087 | 22 | 0A | 01 | SHLD RSR   | Restore Rcv Shift Reg in RAM     |



ter pair are moved back to RAM, and the required least significant bits are sent as a serial character. Actually, eight bits are sent to the UART, and the way it is configured determines how many bits will be used in the character sent.

In the receiving section of the program, the least significant bit of the received character, the bit to be checked, is moved into the most significant bit of the E register. After the two least significant bits of the shift register contents are isolated by masking, the E register is ORed with the accumulator to leave an eight-bit number with only three active bits. These three bits represent the two feedback taps and the incoming bit that is being checked. If the parity of the accumulator contents is even, the bit is good. If the parity is odd, the received bit is bad and the error count for that character is incremented (in BCD).

After each bit is checked, the receiving shift register, contained in the HL register, is shifted. The checking and shifting are repeated until all of the information bits are checked. Then the error total is updated.

The error count is output as "BER/1014 = XXXX." This is a

cryptic way of saying that the bit error rate per 10<sup>4</sup> bits is XXXX. In actuality, 10,000 bits were not really checked. Remember that each error going through the receiving shift register produces three counts. For this reason, only 3333 bits need to be checked. For ASCII characters with seven information bits, this represents 476 characters. In hexadecimal this is 1DC. This is the value to which the character count is reset for each measurement cycle.

To run the program, you must call it from your operating system or another program. The program saves all of the 8080 registers and restores them when the test program is terminated. The only assumption made by the program is that the stack pointer has been properly initialized. Space for at least 14 bytes on the stack must be available.

Pressing the space bar on your keyboard during execution will reset the error total and initiate a new measuring cycle. This is useful to clear the count after the data path has been interrupted. This includes any time that the program is called, since the receiving register will take two or three characters to

| Port | Direction | Function of Port   | Status Bit Information                      |
|------|-----------|--------------------|---|
| 00   | Out       | Data to Modem      |   |
| 00   | In        | Data from Modem    |   |
| 01   | In        | Status of Port 00  | b0-Output Buffer Empty; b1-Input Data Ready |
| 02   | In        | Data from Keyboard |   |
| 03   | In        | Status of Port 02  | b1-Keyboard Data Ready                      |

Table 2. Input/output port assignments used in the program. Use of status bits is indicated.

properly synchronize with the incoming PRBS.

Note that the program will continue to send characters as long as it is executing. The error count will be output only during times that characters are being received. If the program is to be used for receive-only measurements, such as in half-duplex data systems or tape applications, the transmit serial output can be ignored.

To terminate the operation of the test program, type "Control-C" (the end-of-text character). The routine will "pop" all of the original contents of the 8080 registers and will return to the calling program.

### Program Modifications

It is extremely unlikely that the program as listed will run on anybody's system but mine. My system is Z-80 based and has

two RS-232C serial I/O ports. One of them is used to interface a serial keyboard. The other is used to connect to a modem or other communications device. The measurement of error rate is displayed via a DMA video interface using a standard driver routine that is part of my system monitor program.

The addresses of the I/O ports in my system and the associated status bits are given in Table 2. Besides modifying the I/O assignments, the only other change that should be necessary is to supply the address of the routine that you use to send data to your CRT. Although my CRT is driven by a shared-memory interface, any output device is usable. The output device must be at least as fast as the system being tested. For instance, a 1200 baud CRT terminal would do nicely if the data

|      |      |    |    |             |                                 |                               |
|------|------|----|----|-------------|---------------------------------|-------------------------------|
| 008A | 2A   | 0C | 01 | LJLD ERRCNT | Get error total from RAM        |                               |
| 008B | 78   |    |    | MOV A,B     | Contains Char Error Count       |                               |
| 008C | 85   |    |    | ADD L       | Add LSD Error Counter           |                               |
| 008D | 27   |    |    | DAA         | in BCD                          |                               |
| 008E | 6F   |    |    | MOV L,A     | Clear A but not Carry           |                               |
| 008F | 27   |    |    | ADC H       | Add Carry & MSD of Error Count  |                               |
| 0090 | 3E   | 00 |    | DAA         | in BCD                          |                               |
| 0091 | 8C   |    |    | MOV H,A     | Return Error Total to RAM       |                               |
| 0092 | 27   |    |    | SHLD ERRCNT | Get Character Counter from RAM  |                               |
| 0093 | 22   | 0C | 01 | LDX H       | Decrement it                    |                               |
| 0094 | 2B   | 06 | 01 | SHLD CHCNT  | And return to RAM               |                               |
| 0095 | 22   | 06 | 01 | MOV A,H     | Check it for zero               |                               |
| 0096 | 7C   |    |    | ORA L       | If not zero, bypass buffer load |                               |
| 0097 | B5   |    |    | JNZ DSPE    | Set up pointer to Text Buffer   |                               |
| 0098 | C2   | BF | 00 | LXI H,TBPR  | Get high byte of Error Count    |                               |
| 0099 | 00A5 | 21 | 00 | LDA HIERCT  | Hex to ASCII & into Buffer      |                               |
| 009A | 3A   | 0D | 01 | CALL BCDS   | Get low byte of Error Count     |                               |
| 009B | CA   | EC | 00 | LDA ERRCNT  | Hex to ASCII & into Buffer      |                               |
| 009C | 3D   | 05 | 00 | CALL BCDS   | Initialize Buffer Counter       |                               |
| 009D | CD   | E5 | 00 | MOV A,OFH   | and keep in RAM                 |                               |
| 009E | 3E   | 0F |    | STA TXTCNT  | Set pointer to message area     |                               |
| 009F | 32   | 05 | 01 | LXI H,MSG   | and keep in RAM                 |                               |
| 00A0 | 21   | F5 | 00 | SHLD TXTPTR | Get Text Counter from RAM       |                               |
| 00A1 | 22   | 0E | 01 | LDA TXTCNT  | Check for zero                  |                               |
| 00A2 | 3A   | 05 | 01 | ORA A       | If no more, back to beginning   |                               |
| 00A3 | C2   | BF | 00 | JZ CONTRL   | If more text, reduce Counter    |                               |
| 00A4 | CA   | 0B | 00 | DCR A       | and put back in RAM             |                               |
| 00A5 | 3D   |    |    | STA TXTCNT  | Get Text Pointer                |                               |
| 00A6 | 0C7  | 32 | 05 | 01          | LJLD TXTPTR                     | Get Message Char pointed to   |
| 00A7 | 0CA  | 2A | 0E | 01          | MOV A,M                         | and have it displayed on CRT  |
| 00A8 | 0CD  | 7E |    | CALL CHD    | Bump pointer value              |                               |
| 00A9 | 0CE  | CD | 03 | F8          | INX H                           | Go back to beginning for more |
| 00AA | 0D1  | 23 |    |             | SHLD TXTPTR                     | LXI H,01DCH                   |
| 00AB | 0D2  | C3 | 0B | 00          | JMP CONTRL                      | No. of char per measurement   |
| 00AC | 0D5  | C3 | 0B | 00          | LXI H,01DCH                     | Zero value                    |
| 00AD | 0D8  | 21 | DC | 01          | SHLD CHCNT                      | put into Error Counter        |
| 00AE | 0DB  | 22 | 06 | 01          | LXI H,0000H                     | Temporarily hold number       |
| 00AF | 0DE  | 21 | 00 | 00          | SHLD ERRCNT                     | Rotate                        |
| 00B0 | 0E1  | 22 | 0C | 01          | RET                             | to                            |
| 00B1 | 0E4  | C9 |    |             | MOV B,A                         | get the                       |
| 00B2 | 0E5  | 47 |    |             | RRC                             | higher hex digit              |
| 00B3 | 0E6  | 0F |    |             | RRC                             | Convert hex digit to ASCII    |
| 00B4 | 0E7  | 0F |    |             | RRC                             | Now do lower hex digit        |
| 00B5 | 0E8  | 0F |    |             | RRC                             | Select lower four bits        |
| 00B6 | 0E9  | 0F |    |             | RRC                             | Make it an ASCII numeral      |
| 00B7 | 0EA  | CD | EE | 00          | CALL ASCII                      | Place in buffer area          |
| 00B8 | 0ED  | 78 |    |             | MOV A,B                         | Bump pointer value            |
| 00B9 | 0EE  | E6 | 0F |             | ANI 0FH                         | Carriage Return               |
| 00BA | 0F0  | F6 | 30 |             | ORI 30H                         | Line Feed                     |
| 00BB | 0F2  | 77 |    |             | MOV M,A                         | 'B'                           |
| 00BC | 0F3  | 23 |    |             | INX H                           | 'E'                           |
| 00BD | 0F4  | C9 |    |             | RET                             | 'R'                           |
| 00BE | 0F5  | 0D |    |             | MSG                             | '/'                           |
| 00BF | 0F6  | 0A |    |             | ASCII                           | '1'                           |
| 00C0 | 0F7  | 42 |    |             | ASCII                           | '0'                           |
| 00C1 | 0F8  | 45 |    |             | ASCII                           | '0'                           |
| 00C2 | 0F9  | 52 |    |             | ASCII                           | '0'                           |
| 00C3 | 0FA  | 2F |    |             | ASCII                           | '0'                           |
| 00C4 | 0FB  | 31 |    |             | ASCII                           | '0'                           |
| 00C5 | 0FC  | 30 |    |             | ASCII                           | '0'                           |
| 00C6 | 0FD  | 5E |    |             | ASCII                           | '0'                           |
| 00C7 | 0FE  | 34 |    |             | ASCII                           | '0'                           |
| 00C8 | 0FF  | 3D |    |             | ASCII                           | '0'                           |
| 00C9 | 0100 | 30 |    |             | ASCII                           | '0'                           |
| 00CA | 0101 | 30 |    |             | ASCII                           | '0'                           |
| 00CB | 0102 | 30 |    |             | ASCII                           | '0'                           |
| 00CC | 0103 | 30 |    |             | ASCII                           | '0'                           |
| 00CD | 0104 | 00 |    |             | NO                              | '0'                           |
| 00CE | 0105 | 00 |    |             | NO                              | '0'                           |
| 00CF | 0106 | DC | 01 |             | DATA                            | '0'                           |
| 00D0 | 0108 | 55 | 55 |             | DATA                            | '0'                           |
| 00D1 | 010A | 55 | 55 |             | DATA                            | '0'                           |
| 00D2 | 010C | 00 |    |             | ERRCNT                          | '0'                           |
| 00D3 | 010D | 00 |    |             | DATA                            | '0'                           |
| 00D4 | 010E | F5 | 00 |             | DATA                            | '0'                           |
| 00D5 | 0110 |    |    |             | DATA                            | '0'                           |
| 00D6 | 0110 |    |    |             | DATA                            | '0'                           |



| Number of Information Bits Used | Constant at 002E and 0047 | Two-byte constant at 00D9-00DA for an equivalent measurement of about |                      |                      |                      | Time for a 10 <sup>4</sup> bit measurement cycle seconds (with bps) |
|---------------------------------|---------------------------|---|----------------------|----------------------|----------------------|---|
|                                 |                           | 10 <sup>2</sup> Bits  | 10 <sup>3</sup> Bits | 10 <sup>4</sup> Bits | 10 <sup>5</sup> Bits |   |
| 5                               | 05                        | 0043  | 029B                 | 1A0B                 | FFFF*                | 110 (45.5)  |
| 6                               | 06                        | 0038  | 022C                 | 15B4                 | D904                 | 41 (110)  |
| 7                               | 07                        | 0030  | 01DC                 | 129A                 | BA03                 | 16 (300)  |
| 8                               | 08                        | 0024  | 01A1                 | 1047                 | A2C3                 | 3.5 (1200)  |

\* Will give results about 1.7 percent too low. Length of measurement period is over three hours at 45.5 bps!

Table 3. Hexadecimal constants to be changed to give proper operation with a different number of information bits and with different measuring intervals. Approximate measurement cycle times are given for various data rates. Constants used in program are indicated in boxes.

link being measured were running at 1200 baud or less.

In addition to modifying the program to fit your system, you may want to change the equivalent number of bits over which the error rate is measured. For systems which are virtually error-free, a greater number of bits should be checked to give a higher probability of finding erroneous bits. Fewer bits per measuring cycle are desirable when system reliability is poor or to shorten the cycle time when making adjustments to improve performance.

Table 3 gives the constants that must be changed in the program to vary the number of bits per measurement cycle. Values for characters with five to eight information bits are included. An indication of the cycle time is given for some typical data rates. The values in boxes are those from the original program.

#### Applications

A common use of the program is to send test sequences over a loopback. Several different arrangements are shown in Fig. 4.

Note that the loopback may be for digital signals, such as RS-232, directly at the computer or at the interface to the terminal equipment at the other end, or it may be for analog signals at either the sending

modem or at the far end of the transmission path.

Some commercial modems have the capability of being looped-back at various points under control from a remote location. This permits main-

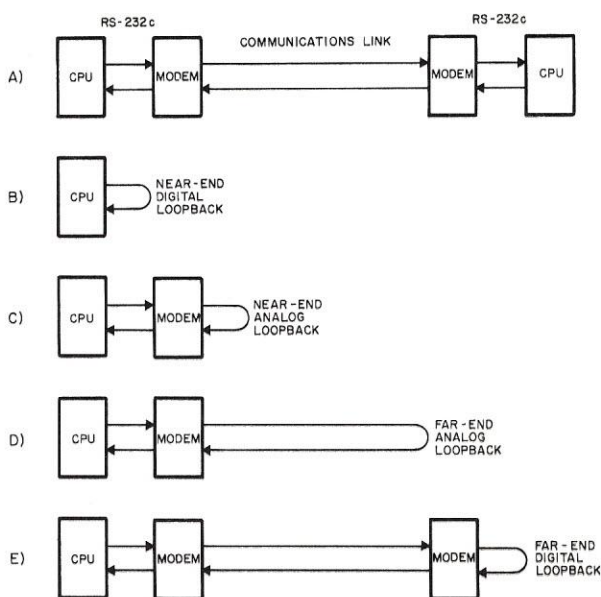


Fig. 4. Equipment arrangements for testing with the program. With the program executing in two communicating computers, configuration a can be used. Testing from one end only is possible with digital or analog loopbacks at various points as in b, c, d or e.

tenance to be done without requiring manual patching of signals. The part of the system causing a problem can easily be isolated with this technique.

Of course, tests between two computers can be done if both of the processors are executing the program at the same time. One advantage of this arrangement is that it permits finding sources of errors that occur for transmissions in one direction only. These maybe found by loopback tests, but you will have trouble deciding which half of the loop is the culprit. Testing between two computers is also necessary for systems that are half duplex by nature. Radio channels in the HF spectrum are normally only one direction at a time on the same frequency and must be tested this way.

Another possible use of error-rate testing is to permit adjusting tape interfaces for data recording. The PRBS is first recorded and is then played back to allow counting errors that may be occurring.

#### Final Comments

I hope that this technique for measuring errors is helpful to hobby users of data communications. Even if you think my code is inefficient (which is probably the case), you should be able to use the ideas that are presented, even on other processors.

This method is another simple trick that the commercial people take for granted. As a result, hobbyists never find out the secrets that are "obvious" to the pros. ■

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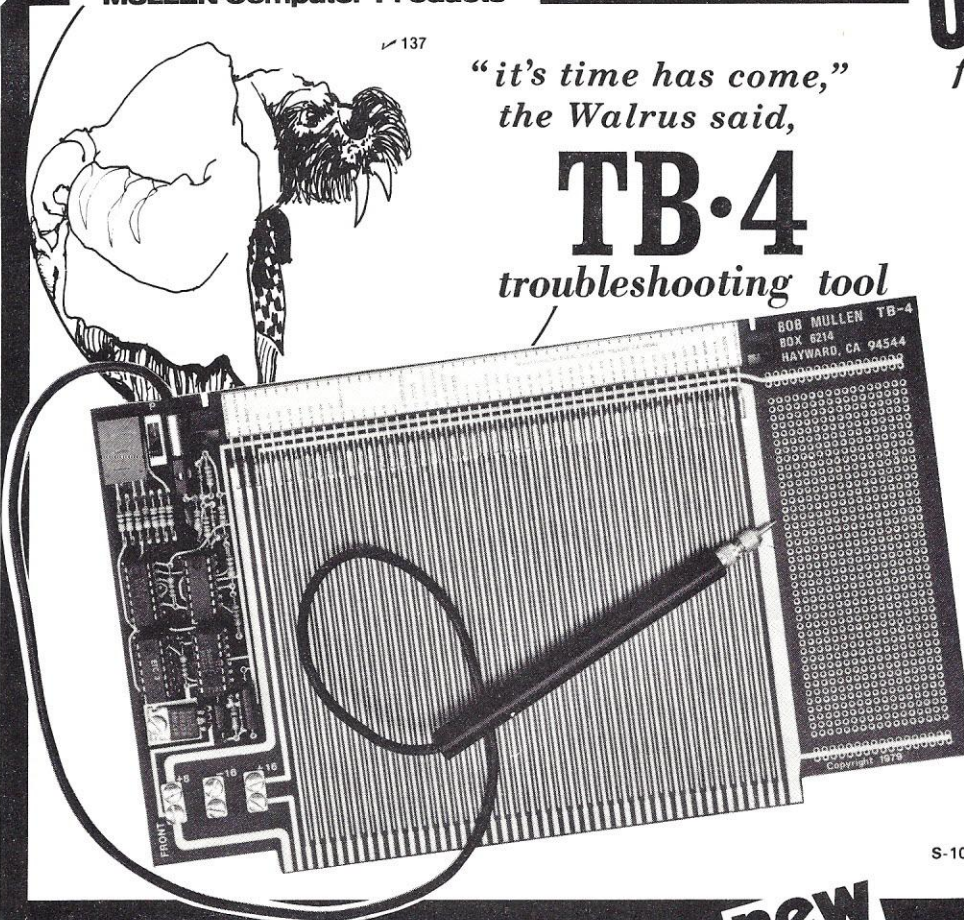
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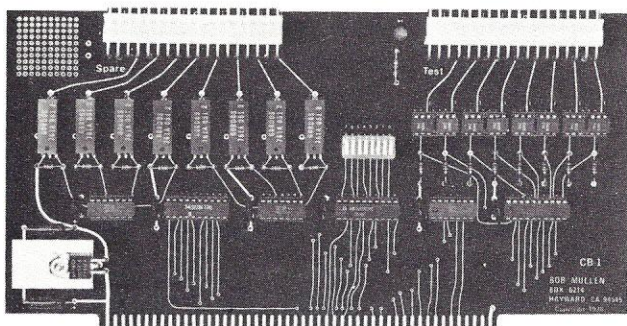
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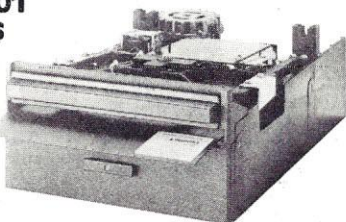
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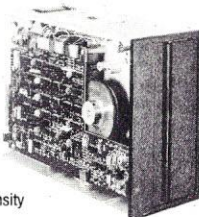
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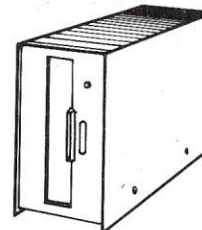
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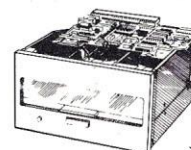


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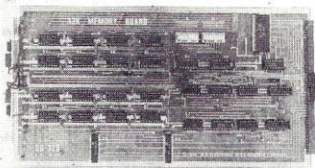
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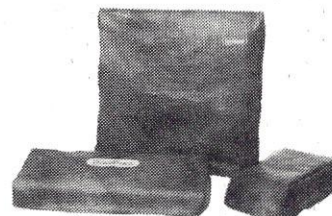
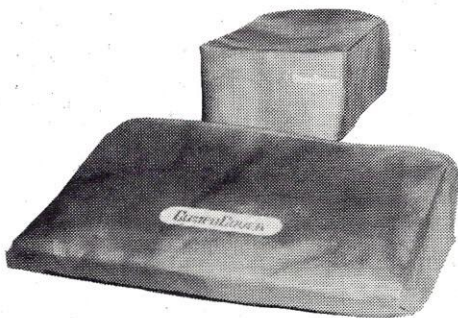
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# Dial-up Directory

---

*Our dedicated dialer tells why the microcomputer is a practical communications device.*

---

Frank J. Derfler, Jr.  
PO Box 17283  
Montgomery AL 36117

**T**his month we will describe the practical aspects of using the home computer as a communications device. We will focus on one outstanding free service and explain some technical terms in simple form.

## Time Tyranny

The U.S. has the most elaborate communications system in the world. Our tightly wired web of communications includes television, radio, cable TV, private carrier systems and the extensive telephone system. The major inconvenience in plugging into this system is that you have to be ready to receive when a message of interest is sent. You have to arrange your life around the time set for the evening news, or you will miss it. You have to be home to receive a phone call, or you will not get it.

Now, a cresting wave of consumer products is helping us break free of the time tyranny of telecommunications. Video recorders, telephone answering machines, portable telephones and mini tape recorders make the messages of the communications system available to us when we want them, not just when the messages are being sent. While you and your family go out to dinner, one tape recorder can record the evening news and another can answer the telephone. Later, at your leisure, you can check to see if the communications system has any messages for you.

This is the idea behind several different kinds of computer communications services available to you today.

These services store information until you are ready to see it. A computer serves as a smart recorder for you, sorting and cataloging data in its memory for easy retrieval. The types of inputs into the computer, the amount of processing and the degree of personal service available generally separate the types of systems.

Personal hobby systems are variously called Computer Bulletin Board Systems (CBBS), Apple Bulletin Board Systems (ABBS), TRS-80 Forums and other similar names. Hobby systems started out as the computer equivalent of simple public bulletin boards, where notices to individuals and the public could be posted. They are now increasing in the amount of personal service they provide at no cost. They often give regular users special sign-on notices and allow quick sorting of messages by categories. Some systems can also store and transfer programs.

Commercial services available to the home user rival any government or private capability. The Source and Micronet are two of these systems. We'll review both of these in an upcoming article.

## Spotlight

Listings are always top-heavy with California systems, but one is tops in flexibility, creativity and reliability: the People's Message System (714-449-5689). Bill Blue is the main person in this people's system, which has all of the standard, and many special, features.

The Apple II Plus that runs this system is dwarfed by its peripherals. The two standard 5-inch drives are aug-

mented by three 8-inch disks and internal ROMs. A clock card, D. C. Hayes Micromodem and local printer complete the package. This large storage capacity provides lengthy "articles" for discussion and comment. It also serves as a program upload and download service for Apple users and others with the right software.

If you type "GENERAL" in response to this system's prompt, you will be in the program mode. You can run programs or select upload/download. This option allows you to store programs in the system for others or to get programs for yourself. The function is designed for Apple users, but instructions are provided for anyone who can save files.

Bill's other special features include Message Alert, Reverse Scan, Flagging and four levels of message security. Message Alert (command M) checks message headers for the name you logged in. It lists all messages with your name in them. This is done automatically at log-on also. Reverse Scan lets you look at the summary of messages from the most recent to those first received. This is a real time-saver! You can use a Scan (S) command to specify a message number higher than the highest number in file.

Flagging is done during a scan. When you see a message you want, just send a control R. At the end of the scan, send an asterisk. The flagged messages will come automatically. The message security system determines who can read and kill specific messages.

A special article is often placed on the system to stimulate discussion.



Much comment was recently generated on a lengthy piece describing experiments in telepathy. This activity turns a bulletin system into a kind of computer magazine with instant reader response. I believe I perceive an iceberg tip on the horizon.

The quality and features of Bill's system pay dividends. Some of the most knowledgeable and interesting computer hackers frequent the People's System.

## Terms

When you use your computer to communicate over phone lines, you may run into some new terms that often are associated with switch or software options. If you don't get the option right, your machine won't talk.

One important term is duplex. As a communications system planner, I thought full duplex meant that the device could transmit and receive at the same time; half duplex meant the device could either receive or transmit, not both, at any one moment. This applies only for a communications link such as a phone line, radio circuit or microwave shot, but it is not true for computer devices.

When computer designers talk about duplex modes, they bring in new words such as echo-back and echo-plex. Echo means a playback of what a computer received from a terminal.

When a terminal is operating in the full-duplex (echo-plex) mode, sent characters go from the keyboard, out the RS-232 port and over the transmission media (channel) to a computer or host device. They are then echoed back to the terminal and displayed on the screen. This provides a continuous verification of the communications path. Note that it is not exactly the simultaneous operation you think of in a full-duplex radio link. Full duplex is the common mode of remote operation for bulletin board systems.

In computer terminals, half duplex means that the character is displayed and transmitted simultaneously. If your terminal thinks it is in half duplex and your host thinks you are in full, you will see everything you send twice. Each character will appear once when you strike the key and again when it is echoed.

When both computer and remote terminal are operating in half duplex they are transmitting "in the blind." The channel could be lost, but they would keep sending. You can lose a lot

of bits that way.

Modems obey the communications rules. Half-duplex modems have to use handshaking to send (RS-232, pin 4) and clear to send (RS-232, pin 5) signal between themselves and their associated terminal or computer. Don't worry about these signals. Full duplex is the common mode of operation.

If you are dialing-up with other individuals, you may run into many different combinations of software, hardware and modems. Software can be particularly confusing because some operating systems echo the screen out the RS-232 port. Other machines echo when in BASIC, but not at other times. It is nearly impossible to make a chart describing all the possibilities.

As a rule, if your computer soft-

ware or hardware thinks you are in full duplex, start out with the modem in "FULL." If you are getting double characters, flip your modem switch to "HALF." Beyond that, you and the other person will have to experiment with different configurations until you get one that works.

## Conclusion

Electronic bulletin systems allow a new use for your computer and an escape from the need to be present to communicate. The price is right, too.

I would like to hear about your good and bad dial-up experiences. Send paper mail (with a stamped envelope, if you want a reply) to PO Box 17283, Montgomery AL 36117. Send electronic mail on the Atlanta Northstar (404-939-1520) or to TCB967 on the Source. ■

The following list provides the location, phone number and other information about dial-up computer communications systems around the country. Note that this list contains the first PET system, the first TRS-80 MOD II and the first Canadian system, as well as creative and practical applications. Unless otherwise shown, all systems operate 24 hours a day. Hit at least three carriage returns to set the speed. I have checked into all of these systems, which were verified from my list of over 120 "reported" systems.

| LOCATION                | PHONE NO.                    | COMMENTS   |
|-------------------------|------------------------------|--|
| <b>British Columbia</b> |                              |  |
| Vancouver               | 604-687-2640                 | Welcome, Canada! CBBS.   |
| <b>California</b>       |                              |  |
| Orange County           | 714-537-7913                 | Forum-80   |
| Palo Alto               | 415-493-7691                 | ABBS   |
| Santa Barbara           | 805-682-7876                 | 8 AM-11 PM Pacific time  |
| Santa Barbara           | 805-964-4115                 | Answers after fourth ring.   |
| <b>Georgia</b>          |                              |  |
| Atlanta                 | 404-939-8429                 | Not full time. ABBS  |
| <b>Iowa</b>             |                              |  |
| Iowa City               | 319-353-6528                 | 5 PM-8 AM Central time. Weekends 24 hours. ABBS. Special-purpose system for medical professionals. Includes medical education programs to run. |
| <b>Michigan</b>         |                              |  |
| Ypsilanti               | 313-484-0732                 | PET. Call Fred Hambrecht at 313-485-1896 (voice) for PET software. This system often doesn't use carriage returns.                             |
| <b>New Jersey</b>       |                              |  |
| Scotch Plains           | 201-753-1225<br>201-968-1074 | Two systems of the Amateur Computer Group of NJ. This club has 1000-plus members and many special interest and user groups.                    |
| <b>New York</b>         |                              |  |
| Endicott                | 607-754-5571                 | Runs on one North Star disk. Centered more on an individual electronic mail approach. Easy to use and fast. A fine program!                    |
| <b>Tennessee</b>        |                              |  |
| Nashville               | 615-254-9193                 | TRS-80 MOD II. Different software from ACS Services.   |
| <b>Utah</b>             |                              |  |
| Logan                   | 801-753-6800                 | ABBS.  |



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- \* **MODEL CF2** ..... Drawer w/interface \$139.95. Drawer only \$99.95  
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- \* **MODEL CF3** ..... Drawer w/interface \$154.95. Drawer only \$114.95  
All steel, brown baked enamel finish with drawer key-lock. Remountable plastic money tray, 5 coin - 5 bill compartment, bill adjustable to 4.  
Size: 15.6" W x 16.6" L x 4.4" H.
- \* **MODEL CF4** ..... Drawer w/interface \$169.95  
All steel, brown baked enamel finish, w/drawer key-lock and drawer release key lock. Removable plastic money tray, 5 bill compartment, bill adjustable to 4.  
Size: 15.6" W x 19.7" L x 4.4" H.
- \* **MODEL CF5** ..... Drawer w/interface \$169.95. Drawer only \$129.95  
All steel, brown baked enamel finish w/drawer key-lock and drawer release key-lock. Removable plastic money tray, 5 coin - 5 bill compartment, bill adjustable to 4.  
Size: 16.5" W x 17.7" L x 4.4" H.
- \* **MODEL CF6** ..... Drawer w/interface \$199.95. Drawer only \$159.95  
All steel, brown baked enamel finish, with drawer release key-lock. Removable plastic money tray, 5 coin - 5 bill compartment, coin compartments contoured for easy change removal.  
Size: 17.3" W x 19.7" L x 4.6" H.



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IAS requires 32K of memory, North Star Release 4 or later DOS and BASIC and two disk drives. Printer output is provided for, but not required. Specify video device when ordering.

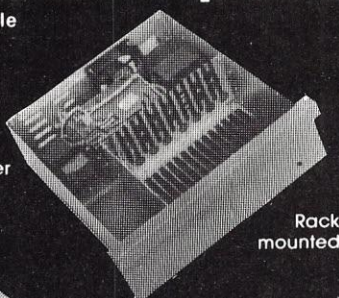
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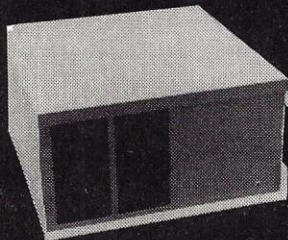
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# Mickey Gets New Ears

*Electronic Systems enhances "Mickey Modem's" "hearing" with its modem board kit.*

Stephen Gibson  
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Los Angeles CA 90038

**S**ending data or whole programs over Ma Bell's lines is easy with Mickey Modem (*Kilobaud*, November 1978, p. 52). It's the only inexpensive way to go as long as both computers are the same or use the same cassette-port formats. Unfortu-

nately, two-way communication with a computer unlike yours is another matter. In fact, it's next to impossible without some common interchange method—a "standard," if you want to call it that. Fortunately for us all, someone else already had this problem, so standards exist... several of them!

Nevertheless, the most universal and simplest way to get into operation is the Bell 103

standard. See Fig. 1 for how the Bell 103 ties two computers together. To make the conversion ultra-cheap, I wired the Electronic Systems bare-bones 103 modem board into the original Mickey Modem. The price for the kit (Photo 1) was so low (\$27.50) that I bought two modems and implemented both originate and answer capability, thereby ending forever my telephone-interface hassles. This

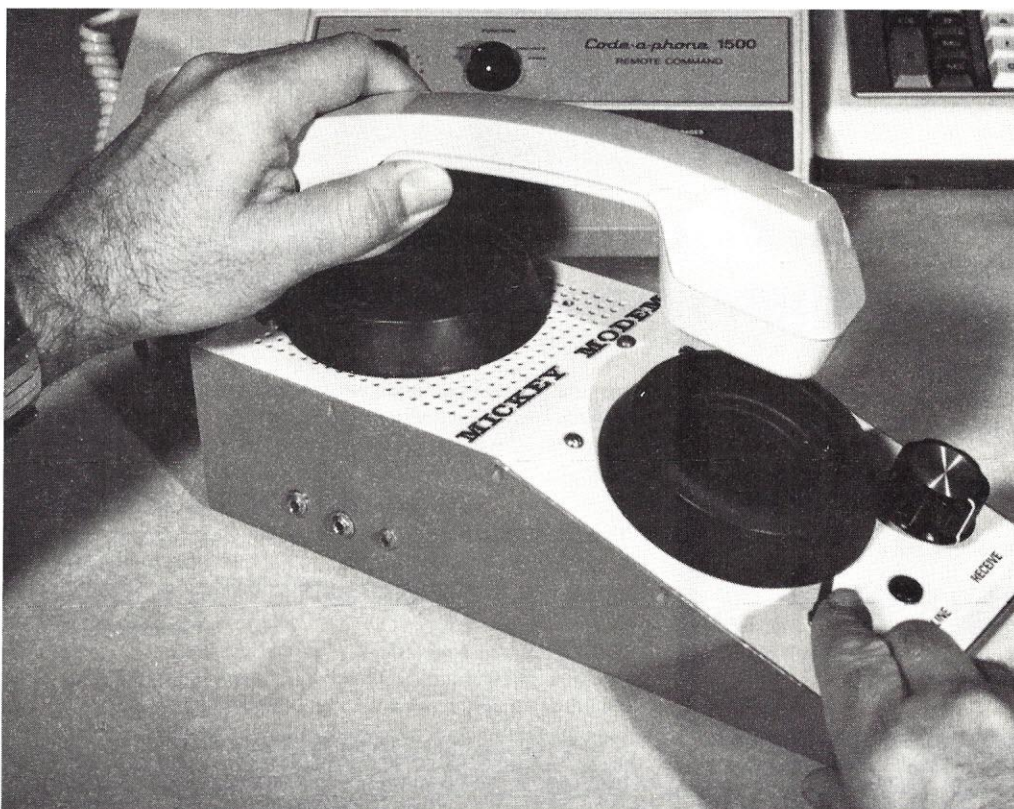
"standard" Mickey appears to be a budget way to beat the high modem price barrier.

The modem kit can be wired for either originate or answer modes. If your plans are to only talk with a time-share computer, then you may only need an originate modem. If you really wanted to keep expenses down, you could use one kit and switch the few frequency-changing components back and forth from originate to answer. I don't recommend it. The extra capacity from wires running everywhere will make your modem drift all over the place! I know; I tried.

## New Circuit Description

All that's involved with the conversion are a few simple modifications to accommodate the new PC board(s). While it may be possible to use the Electronic Systems modem wholly alone, I think the added goodies from Mickey Modem will give you a much better running unit equaling those costing more than \$100.

In the clever Electronic Systems design in Fig. 2, the modem board tone receiver uses an XR-2211 phase-lock-loop IC to convert the received frequencies to logic 1s and 0s. To transmit, a 567 phase-lock-loop oscillator is simply shifted in frequency by a single transistor that switches a frequency-changing capacitor in and out of the circuit. Both PLL ICs can be wired for either



*Two printed circuit modem kits and a few leftovers from the original Mickey Modem make this originate/answer unit inexpensive and easy to build.*



|         | Part   | Calculated | Actual   |
|---------|--------|------------|----------|
| 2125 Hz | R1, R2 | 786 Ohms   | 820 Ohms |
|         | R3     | 393 Ohms   | 390 Ohms |
|         | C1     | .2 uF      | .15 uF   |
|         | C2, C3 | .1 uF      | .1 uF    |
| 1170 Hz | R1, R2 | 907 Ohms   | 820 Ohms |
|         | R3     | 453 Ohms   | 560 Ohms |
|         | C1     | .33 uF     | .33 uF   |
|         | C2, C3 | .15 uF     | .15 uF   |

Table 1. Simple notch filter circuit values.

originate or answer frequencies.

The circuit diagram to the new standard Mickey is shown in Fig. 3. I chose to acoustically couple the new Mickey to the Ma Bell system. I used a crystal microphone element, which had too low an output to drive the PLL receiver from the line. So I made a trip down to my obsequious Radio Shack store to get another one. After some testing in my lab, I resolved that they didn't have a high-output microphone either. Clearly, I needed some gain. . . at least enough to drive the modem board. I ended up using one of Mickey's LM386 ICs.

Now the microphone had plenty of level to drive the chip. In fact, I had so much gain that I was able to add a couple of simple RC notch filters to the amplifier output to cancel side-tone frequencies from the modem oscillator. The feedback from the oscillator can sometimes cause the demodulator PLL IC to lock up on the modulator.

Clearly, a no-no. The notch filters are each tuned to a midway point between each of the two frequency groups.

Of course, an active notch filter might have been better over this configuration. A hi pass and low pass would work too. But why bother with more ICs and parts when, even with sloppy tuning, you can get 15 to 20 db rejection, which is more than enough? Besides, I wanted to test out the RC notch filter program in the January 1979 issue of *73 Magazine* ("Design-a-Notcher," p.100).

A summary of the values I computed are in Table 1. The nearest EIA values I used are there too. Depending on tolerances, you may have to juggle them just a bit if you wish to hit the notch frequencies exactly.

My modem board didn't have enough output level to work long distances. So I used a 99¢ 500 to 8 Ohm speaker matching transformer. I now had enough level to send solid copy any-

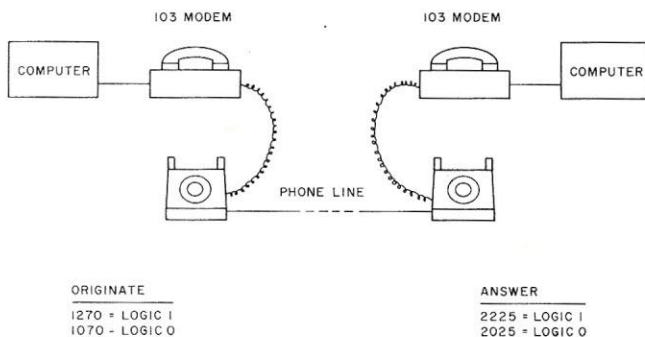


Fig. 1. A Bell 103 setup. Two-way communication is possible because separate frequencies are used to send and receive. Notice that the higher frequency of each pair is a logic 1 (also called a mark).

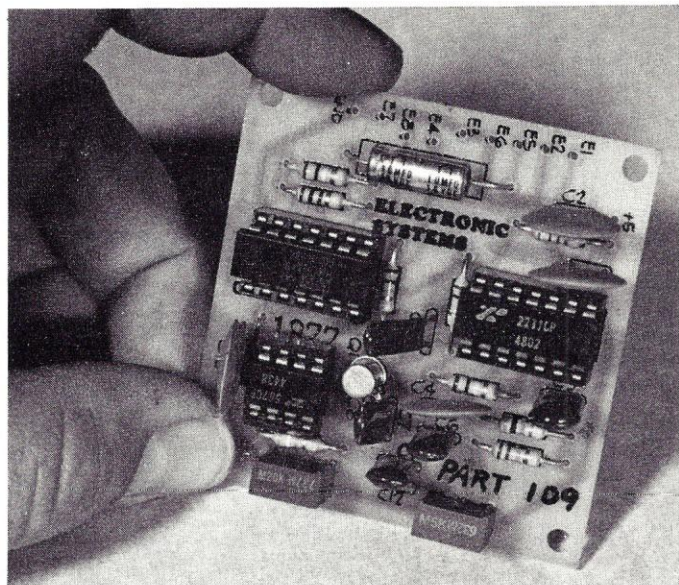


Photo 1. A nifty add-on to Mickey Modem. The Electronic Systems 103 modem kit can be wired for originate or answer frequencies.

where. That's really saying a lot because my local phone office is the old Hollywood exchange. And like everything else about Hollywood, "It was great in the 30s, but now. . ."

As a final touch to make Mickey's new ears perk up, I wired a simple carrier-detect LED circuit. If the modem receives a mark frequency (originate or answer mode),

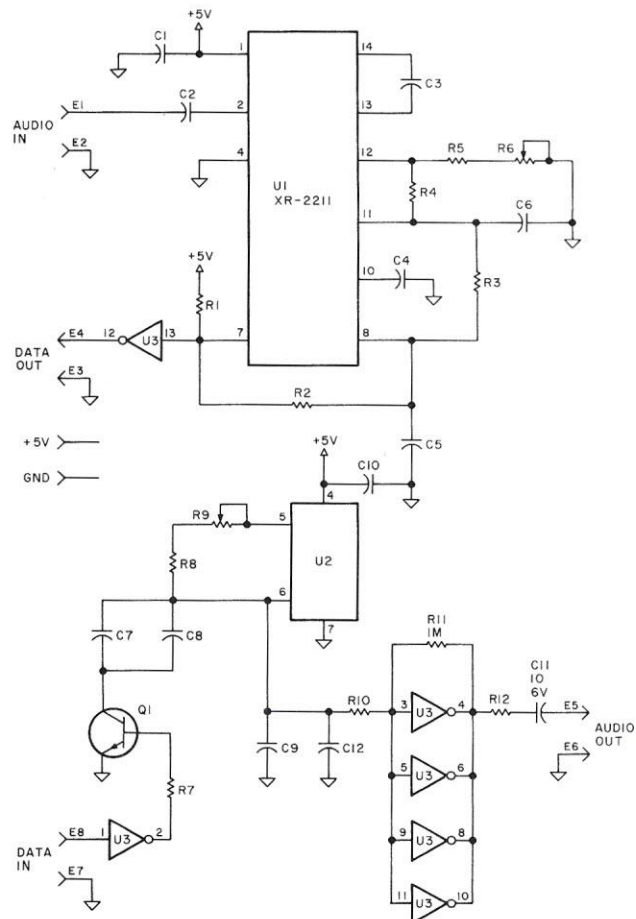


Fig. 2. Use of PLLs makes this circuit easy to tune. Reversing the values of R10 and R11 will increase output.



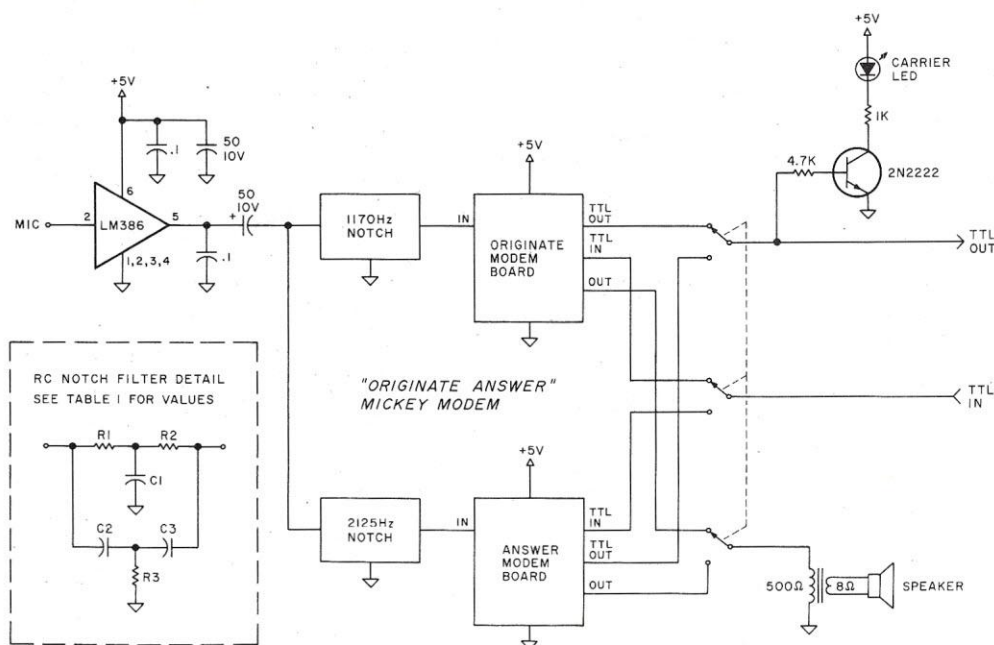


Fig. 3. Modify your Mickey Modem to work computers thousands of miles away with this circuit. An LM386 IC amp boosts the input signal out of the mud to feed 103 Modem kits through noise-reducing filters. A 99 cent transformer ensures a high level to the speaker. The 2N2222 transistor lights the LED to indicate a carrier or mark condition.

which indicates a valid connection, a single 2N2222 transistor will turn on the carrier-detection LED. Pin 5 (unused) of the XR-2211 PLL already has this feature. I opted for the external transistor rather than risk zapping the XR-2211. A three-pole, two-position transfers operation to either modem board.

#### Whither RS-232?

The inputs and outputs are TTL levels. If you plan to wire your modem directly to the computer and your wires are short, you just might get away with TTL all the way to your mainframe. If the connection is more than a few feet though, you'd be wise to use RS-232 levels. It's difficult to interconnect two units if one is RS-232 and the other isn't. TTL and RS-232 don't connect in a convenient translatable form. In fact, you may damage a TTL device if you connect an RS-232 signal to it.

The reason is simple. TTL levels amount to a logic 1 equaling about 5 volts positive, while a logic 0 is roughly 0 volts. Fine so far. On the other hand, an RS-232 signal logic 1 ranges anywhere from -3 to 9 volts, and a logic 0 is +3 to 9 volts. They almost look backwards, don't they?

Fortunately, you can use a single 1488 and/or 1489 IC to translate either way. Look at Fig. 4. Notice that when you send a TTL logic 1 into the 1488 line driver, you still get a TTL logic 1 out of the 1489 receiver. Neat, huh?...especially since you can send RS-232 signals all over the place and not pick up a lot of system-crashing noise.

If your computer serial I/O board has RS-232 levels, you'll need to make the RS-232 conversion back to TTL logic levels. Remember: you must make conversion at each end of the line. You can use the 1488/1489 ICs, or you might want to use the Electronic Systems RS-232 converter kit (see Photo 2), which sells for \$7. I mounted mine in Mickey Modem on the edge of one of the modem PC boards.

#### Putting It Together

The new parts easily fit into an LMB 1042 box with the old Mickey Modem board. A convenient feature about this box is the sloping panel. The cushions for Mickey's ears make a tighter fit to the telephone handset. I used surplus acoustical-coupler cushions, but foam rubber would work just as well. If you can find an acoustical coupler that's still intact, all the better.

Less work to mount something usually means less grief.

The modem boards are mounted on a few stand-offs above the speaker (see Photo 3). The LM386 IC amp and the notch filters are mounted on a large Radio Shack experimenter's circuit board. Use shielded wire everywhere. The super gain of the LM386 and the sensitivity of the phase-lock loops dictate careful construction practice.

I used an external power supply, but you could very well sandwich it all into one box. Some parts shifting would be necessary, though it's unlikely you will construct your Mickey Modem exactly like mine anyway.

#### Construction Tips

Frequency drift can be a problem with this modem, unless

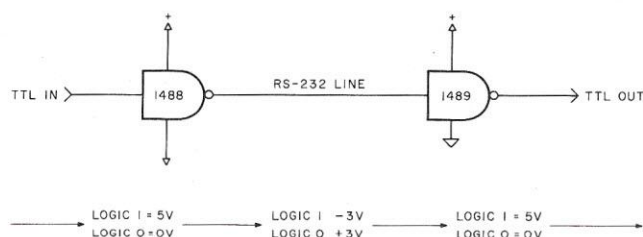


Fig. 4. RS-232 debunked! You can forget about those crazy  $\pm$  voltages when you use converters. If you send a logic 1 into one end of the line, you should get a logic 1 out the other!

you use top-notch capacitors, do a *good* job soldering your PC board connections and use a regulated 5 volt supply. So often I've marveled at the work of PC board solder artists whose work is fantastically beautiful because they use ever so little heat. Yet they scratch their heads in utter amazement when they discover cold solder joints causing their drift problems!

As for regulation, all I can say is that zener diodes are inexpensive. Even the workhorse 7805 IC regulator chip price is within reason, when you consider the frustration you'll likely encounter if your modem drifts.

#### Direct-Connection Method

A 600/600 Ohm line transformer can be used (see Fig. 5) even though the phone-line impedance is somewhere around 900 Ohms. Fortunately, the few db lost don't upset things too much. Neither does the fact that the modulator and demodulator present dissimilar impedances to the network. If you are a purist, change R12 on the modem board to 620 Ohms and load the input to the LM386 with 620 Ohms.

A better null is possible, but hardly worth the effort when the RC notch filters that follow the amp manage to bury what little is left of the side tone. Rx is used to balance out the transmitted signal from being heard by the receiver. About 20 to 30 db rejection is possible with this arrangement. You can sometimes pick up an extra db or two when Rx is bridged with Cx, which can range from .01  $\mu$ F to .1  $\mu$ F.

If you can't find a 600/600 Ohm transformer, try 500/500 or 1000/1000 Ohms. The mismatch is only a few db either way. You



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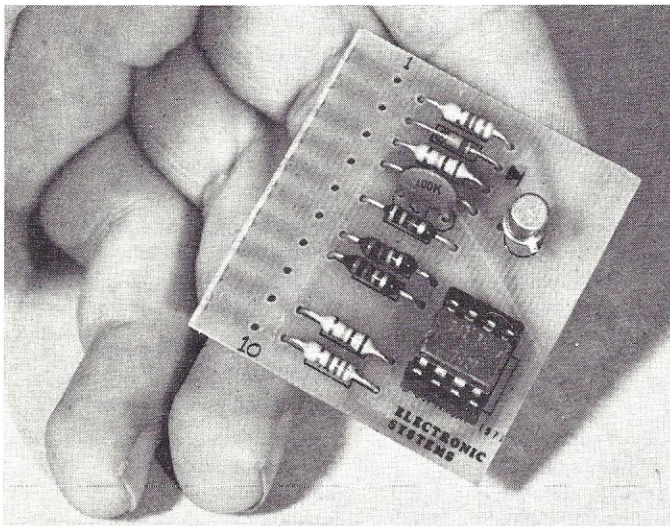


Photo 2. The \$7 RS-232 converter board from Electronic Systems.

can even use two 1000/8 Ohm speaker matching transformers wired back to back! By the way, you do know you are supposed to tie your modem to the line via an approved coupler, don't you? I know it seems crazy having your 600 Ohm matching transformer feeding their 600 matching transformer and then the line, but that's the law!

#### Tune-up Tips

Here's how to tune an originate modem. The exact details for an answer modem are the same; only the frequencies are reversed:

An audio oscillator, scope and frequency counter are best to adjust the modulator section. To use the frequency counter, simply connect it to the modem

output and read the frequency while the modem is held at a logic 1 (5 volts TTL or -3 to -9 volts for RS-232). Adjust R9 for 1270 Hz. Switch to a transmitted logic 0 to see that you are sending roughly 1070 Hz. Adjust the size of C7 to get within 5 cycles of 1070 Hz. You could easily rock R9 a few cycles either way and still have the 1270 Hz within the range of a demodulator.

It's possible to get these frequencies "right on" with little effort. Depending on the other modem you may be talking to, you could very well be off by as much as 30 cycles and still have it work. Stay within 5 cycles to be safe though.

If you don't have a frequency counter, you can feed the modem to the scope's vertical

input and a good oscillator to the horizontal input (see Fig. 6). When both units are set at the same frequency, you should see a slanted line at about 45 degrees, depending on signal levels, scope gain, etc. Set the oscillator to 1270 Hz and feed a logic 1 into the modem modulator. You might see a square or a bunch of spinning circles. These are called Lissajous figures. Adjust R9 until the figures stop moving; adjust for a single circle. Notice that you can rotate it in apparent three dimensions.

Now gently move R9 until you get a slanted line. This method is as accurate as your oscillator. Now change the oscillator frequency to 1070 Hz and feed the modulator with a logic 0. Adjust the size of C7 until you see another slanted line on the scope.

To adjust the demodulator section, you simply bridge the microphone input with the oscillator set to 2225 Hz (a logic 1) at -30 to -40 dbm. Adjust R6 to light the LED or see a logic 1 on the modem output. Switch the oscillator to 2025 Hz and see

that the LED goes out (logic 0).

Ideally, the transition from 1 to 0 should occur midway between 2025 Hz and 2225 Hz, or about 2125 Hz. Jockey R6 and the oscillator around until you achieve a transition at about this frequency. Then you must verify that you still have a logic 1 at 2225 Hz and a 0 at 2025 Hz. Remember: the procedures for an answer modem are the same, but the send and receive frequencies are reversed. Refer back to Fig. 1 for the frequencies.

The last adjustment requires an ac multimeter with a db scale. Check that the tone-send level is no greater than -10 dbm

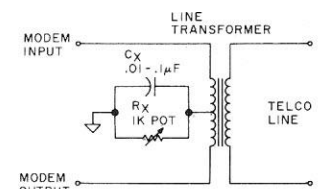


Fig. 5. Direct-connection technique using a line transformer in a hybrid circuit. Adjust Rx to minimize feedback into input.

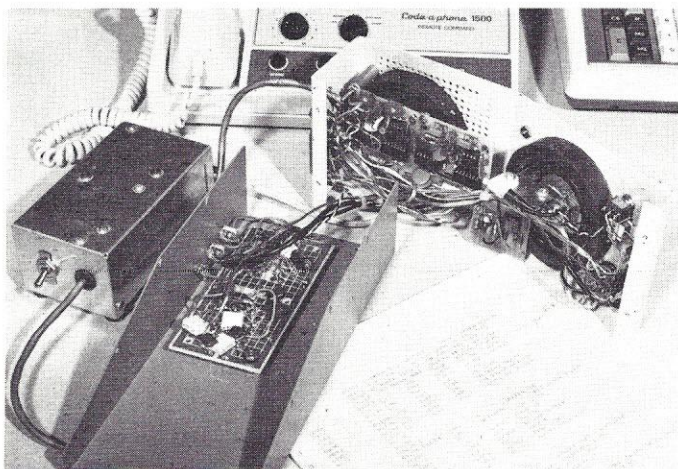
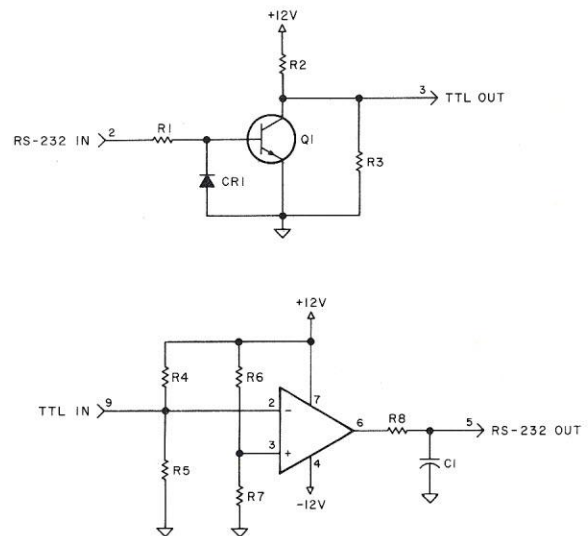


Photo 3. Mickey minus his ears. The microphone amp and notch filters are mounted on the bottom. The two modem boards mount on stand-offs above the speaker. An external power supply was used.



Circuit for Photo 2.

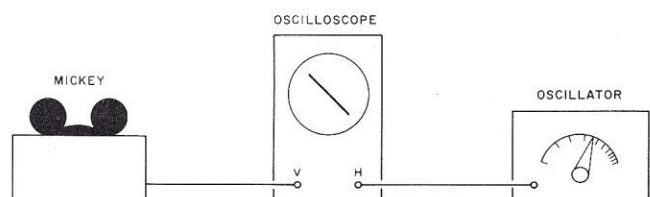


Fig. 6. Equal frequencies from the oscillator and Mickey will display a slant line (45°) on the scope.

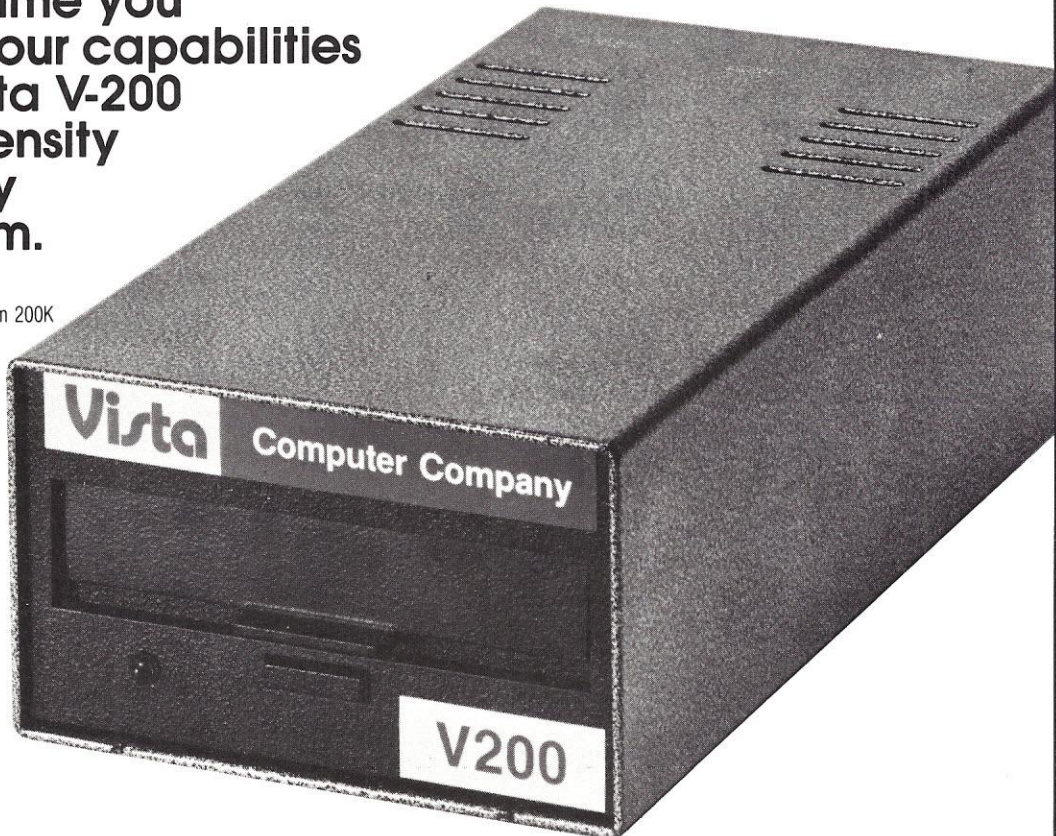


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Listing 1. A software UART terminal program for an 8080 single-bit input.

```

0001 ;
0002 ; SOFTWARE UART/MODEM PROGRAM
0003 ;
0004 ; 1978 STEPHEN GIBSON
0005 ;
0010 ; THIS PROGRAM IS A CHEAP AND DIRTY WAY
0015 ; TO GET YOUR MODEM WORKING. IT USES A
0020 ; SINGLE BIT FROM ANY I/O PORT AND DOES
0025 ; SERIAL TO PARALLEL (AND BACK) CONVERSION.
0028 ; THE HEX VALUES FOR BAUD RATES OF 110
0030 ; AND 300 ARE LISTED IN THE TABLE BELOW.
0035 ; THESE RATES ARE FOR AN 8080 2MC CLOCK
0040 ; WITH THE PROGRAM IN RAM. A HALF OR FULL
0045 ; DUPLEX SWITCH OPTION IS TIED TO PORT FF.
0050 ;
0055 TSTAT EQU 00H ; TERMINAL STATUS PORT
0060 TDATA EQU 01H ; TERMINAL DATA PORT
0065 RMASK EQU 01H ; TERMINAL RECEIVE MASK
0070 SMASK EQU 080H ; TERMINAL SEND MASK
0075 MMASK EQU 01H ; MODEM I/O BIT MASK
0080 DMASK EQU 080H ; SENSE SWITCH MASK
0085 DPORT EQU 0FFH ; SENSE SWITCH PORT
0090 MPORT EQU 02H ; MODEM I/O PORT (BIT 0)
0092 HBAUD EQU 0056H ; 300 BAUD DELAY VALUE
0095 LBAUD EQU 00EEH ; 110 BAUD DELAY VALUE
0098 ;
0100 ORG 05000H
0110 LXI SP,05000H
0115 EI
0120 MVI C,01 ; GET A 'MARK'
0130 CALL OUTPT ; SEND TO MODEM
0140 ;
0150 LOOP CALL MODEM ; CHECK MODEM STATUS
0160 CALL TTY ; CHECK TTY STATUS
0170 JMP LOOP ; KEEP DOING IT
0180 ;
0200 MODEM LXI B,0800H ; SET B TO 8, CLEAR C
0210 IN MPORT ; GET MODEM DATA BIT
0220 ANI MMASK ; TEST LSB
0230 RNZ ; GO CK TERMINAL
0240 ;
0250 CALL DLY1 ; DELAY 1/2 BIT TIME
0260 IN MPORT ; VERIFY START BIT
0270 ANI MMASK ; TEST LSB AGAIN
0280 RNZ ; MUST BE NOISE
0290 ;
0300 INPUT CALL DLY2 ; DELAY 1 BIT
0310 IN MPORT ; GET NEXT BIT
0320 ANI MMASK ; TEST LSB
0330 ORA C ; GET PREVIOUS BITS
0340 RRC ; ROTATE 0 TO 7
0350 MOV C,A ; SAVE IN C
0360 DCR B ; COUNT DOWN 8
0370 JNZ INPUT ; GET NEXT BIT
0380 CALL DLY2 ; DELAY 1 BIT TIME ONLY
0390 CALL CHARO ; PRINT ON TERMINAL
0395 RET ; GO BACK TO LOOP
0400 ;
0410 TTY IN TSTAT ; CHECK TERMINAL STATUS
0420 ANI RMASK ; TEST LSB
0430 RNZ ; GO CK MODEM
0440 ;
0450 IN TDATA ; GET DATA BYTE
0470 MOV C,A ; STORE IN C
0480 CALL DUPLX ; DO WE ECHO?
0490 CALL OUTPT ; SEND TO MODEM
0495 RET ; GO BACK TO LOOP
0500 ;
0510 IN UPORT ; LOCK AT SENSE SW
0520 ANI DMASK ; MASK ALL BUT SW 15
0530 RZ ; IS IT DUPLEX?
0540 CALL CHARO ; MUST BE HALF DUPLEX
0550 RET ; PACK TO TTY
0560 ;
0570 OUTPT MVI B,8 ; BIT CTR
0580 XRA A ; CLEAR A
0590 OUT MPORT ; OUTPUT START BIT
0600 CALL DLY2 ; DELAY 1 BIT TIME
0610 JMP $ ; 30
0620 JMP $ ; CLOCKS
0625 JMP $ ; FOR BALANCE
0630 MOV A,C ; GET BYTE
0640 BITO OUT MPORT ; OUTPUT BIT
0650 CALL DLY2 ; DELAY 1 BIT TIME
0660 RRC ; ROTATE TO NEXT BIT
0670 NOP ; 16 CLOCKS
0680 NOP ; FOR
0690 NOP ; MORE
0700 NOP ; BALANCE
0710 DCR B ; COUNT DOWN BITS
0720 JNZ BITO ; SEND MORE?
0730 MVI A,01H ; SET STOP BIT
0740 OUT MPORT ; OUTPUT STOP BIT
0750 CALL DLY2 ; FOR 1 BIT ONLY
0755 CALL DLY2 ; FOR 1 BIT ONLY
0760 RET ; BACK TO TTY
0770 ;
0780 CHARO IN TSTAT ; GET TERMINAL STATUS
0790 ANI SMASK ; TEST MSB
0800 JNZ CHARO ; LOOP TILL READY
0810 MOV A,C ; GET BYTE FROM C
0820 ANI 07FH ; CLEAN IT UP
0830 OUT TDATA ; SEND TO TERMINAL
0840 RET ; BACK TO DUPLEX OR INPUT
0850 ;
0860 DLY1 PUSH PSW ; SAVE A
0870 PUSH H ; AND HL
0880 LXI H,LBAUD ; 110 BAUD
0890 JMP DLY ; GO TO IT
0900 ;
0920 DLY2 PUSH PSW ; SAVE A
0930 PUSH H ; AND HL
0940 LXI H,LBAUD ; 110 BAUD
0950 DCR H ; SLOW
0960 DCR H ; DOWN
0970 DAD H ; DOUBLE HALF BIT TIME
0980 DLY MOV A,H ; GET MSB
0990 ORA L ; GET LSB
1000 JZ DONE ; ALL BITS ZERO
1010 NOP ; ADD 4 CLOCKS
1020 DCR H ; AND THIS ONE TOO
1030 JMP DLY ; LOOP AGAIN
1040 DONE POP H ; RESTORE HL
1050 POP PSW ; AND A REG
1060 RET ; EXIT TO MODEM, INPUT, OUTPUT, BIT 0

```

Listing 2. A serial-to-parallel software UART program for the TRS-80. The cassette port is used. A resistor inside the TRS-80 must be removed before you run this program.

```

00010 ; *** TERMINAL I/O PROGRAM ***
00020 ; VERSION 1.0 1979 STEPHEN GIBSON
00030 ;
00040 ; RS-232C SIMULATION!!!!
00050 ;
00060 ; FOR SIMPLEX TWO-WAY COMMUNICATION VIA
00070 ; THE TRS-80 AUDIO CASSETTE PORT.
00080 ; 110 BAUD, HALF DUPLEX, NO LF, NO ECHO
00090 ;
00100 ;
00110 ORG 7D00H ; STICK IT HERE
00120 EQU 0002H ; RS-232 0
00130 HI EQU 0001H ; RS-232 1
00140 T1 EQU 07AH ; 2 MS
00150 LBD EQU 267H ; 9 MS
00160 CRT EQU 33H ; DISPLAY DRIVER
00170 KBD EQU 2BH ; KEYBOARD DRIVER
00180 PORT EQU 221H ; ROM PORT DRIVER
00190 ;
00200 ;
00210 ;
00220 BEGIN EQU $ ; INITIALIZE
00230 LD SP,8000H ; PUT STACK @ 7FFF
00240 DI ; STOP CLOCK
00250 LD A,1CH ; HOME UP
00260 CALL CRT ; WRITE
00270 LD A,1FH ; CLEAR SCREEN
00280 CALL CRT ; WRITE
00290 CALL RESET ; INIT PORT
00300 JR RECV ; ENTER MAIN LOOP
00310 ;
00320 ;
00330 ;
00340 USR1 EQU $ ; RESET PORT + 2MS DELAY
7D00
7D00 310080 00230 LD SP,8000H
7D03 F3 00240 DI
7D04 3E1C 00250 LD A,1CH
7D06 CD3300 00260 CALL CRT
7D09 3E1F 00270 LD A,1FH
7D0B CD3300 00280 CALL CRT
7D0E CD167D 00290 CALL RESET
7D11 1816 00300 JR RECV
00310 ;
00320 ;
00330 ;
7D13 00340 USR1 EQU $

```

nor less than -17 dbm with the telephone coupled up to the modem and phone line dialed up to another party. Too much level is illegal, and too little won't let you make it into the first big time-share computer outside of town.

Depending on speaker efficiency or coupling, you can increase or decrease the send level by adjusting the primary taps on the transformer. A series resistor in the primary will also reduce the level. Don't get carried away with high speaker volume. A varistor in the phone line will limit the absolute level on the line to around 0 dbm. It also generates odd harmonic distortion if overdriven. Keep your levels between -10 and -17 dbm, and you'll do fine.

Direct-connection users can



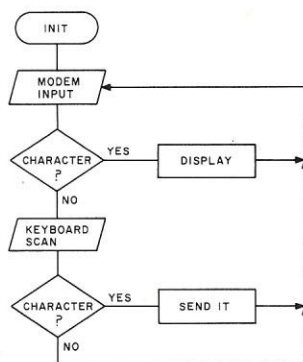


Fig. 7. A simple, duplex modem terminal-program flowchart.

tweak the output level by adjusting the value of R11 on the modem board. Adjust Rx for minimum send level at the opposite end of the transformer. You must, of course, make this final adjustment while connected to the line. Stick to the above-mentioned send levels because the coupler arrangement has a varistor too.

### Mickey Goes On-line

You may have a separate terminal or a terminal program running on your computer. If not, you can write a simple one from the flowchart in Fig. 7. The computer checks first with the modem port and outputs a character if present. Otherwise, it checks your terminal and/or loops around to check the modem again.

You can easily tie Mickey Modem to a serial port. Remember to investigate for RS-232-to-TTL compatibility. You can't mix 'em up without some hardware changes. If you don't have a spare serial port, you can tie Mickey to an unused bit on a parallel port and run the software UART program in Listing 1. The program is commented and should be easy for you to adapt to your machine.

TRS-80 users will find the program in Listing 2 useful. You simply tie Mickey Modem to your cassette port and remove the 100 to 220 Ohm resistor soldered to the cassette jack inside on the back of the main PC board. Of course, you can use the TRS-80 RS-232 board instead. Just be sure to observe the RS-232-to-TTL conventions mentioned previously. ■

```

7D13 CDA37D 00350 CALL DBOUN ;DEBOUNCE 2 MS
7D16 210200 00360 LD HL,LOW ;RS232 MARK
7D19 CD2102 00370 CALL PORT ;SEND IT
7D1C C9 00380 RET ;DONE
;
7D1D 00400 EQU $ ;RESET PORT
7D1D CDA37D 00410 CALL DBOUN ;DEBOUNCE 2 MS
7D20 210200 00420 LD HL,LOW ;RS232 MARK
7D23 CD2102 00430 CALL PORT ;WRITE
7D26 C36D7D 00440 JP KEYS ;LOOP
;
7D29 00450 ;
7D29 010007 00460 ;
7D2C 1600 00470 ;
7D2E DBFF 00480 REC V EQU $ ;SERIAL TO PARALLEL
7D30 17 00490 LD BC,700H ;SET B TO 7, CLEAR C
7D31 303A 00500 LD D,00H ;CLEAR D
; 00510 IN A,(0FFH) ;GET BIT
; 00520 RLA ;SHIFT TO CY
; 00530 JR NC,KEYS ;A SPACE BIT WILL SET CY
; 00540 ; WE HAVE SOMETHING!
7D33 CD137D 00550 CALL USR1 ;RESET PORT
7D36 DBFF 00560 IN A,(0FFH) ;GET BIT
7D38 17 00570 RLA ;MOVE TO CY
7D39 38E2 00580 JR C,USR2 ;NOISE WOULD SET CY
; 00590 ;SO WE RESET AND EXIT
; 00600 ;
; 00610 ;WE NOW HAVE A VALID BYTE COMING IN AND WE
; 00620 ;ARE IN THE MIDDLE OF THE SPACE BIT...SO
; 00630 ;
7D3B CDA87D 00640 INPUT CALL DLY ;DELAY 1 BIT TIME
7D3E DBFF 00650 IN A,(0FFH) ;GET BIT
7D40 E680 00660 AND 80H ;MASK ALL BUT #7
7D42 2022 00670 JR NZ,CHANGE ;A TRANSITION!
7D44 7A 00680 LD A,D ;OTHERWISE,LOAD OLD BYTE
7D45 B1 00690 OR C ;GET PREVIOUS BITS
7D46 0F 00700 RRCA ;MOVE IN
7D47 4F 00710 LD C,A ;SAVE IN C
7D48 CD167D 00720 CALL RESET ;RESET PORT
7D4B 05 00730 DEC B ;COUNT BITS
7D4C 20ED 00740 JR NZ,INPUT ;DONE?
7D4E CDA87D 00750 CALL DLY ;IGNORE PARITY
7D51 CDA87D 00760 CALL DLY ;STOP BIT
7D54 CD167D 00770 CALL RESET ;RESET AFTER STOP BIT
7D57 79 00780 LD A,C ;GET BYTE
7D58 E67F 00790 AND 7FH ;STRIP PARITY
7D5A FE60 00800 CP 60H ;IS IT 60H OR MORE?
7D5C FA617D 00810 JP M,TUBE ;JP AROUND IF NOT
7D5F E65F 00820 AND 5FH ;LOWER TO UPPER CASE
7D61 CD3300 00830 TUBE CALL CRT ;WRITE
7D64 18C3 00840 JR REC V ;LOOK FOR MORE
7D66 AZ 00850 CHANGE AND D ;LAST BYTE
7D67 2F 00860 CPL ;INVERT BYTE
7D68 E680 00870 AND 80H ;CLEAN UP
7D6A 57 00880 LD D,A ;SAVE
7D6B 18D8 00890 JR BACK ;SERIAL RE-ENTRY
; 00900 ;
; 00910 ;
; 00920 ;
7D6D 00930 KEYS EQU $ ;READ KEYBOARD & SEND
7D6D CD2B00 00940 CALL KBD ;ANYONE
7D70 B7 00950 OR A ;THERE?
7D71 28B6 00960 JR Z,RECV ;SO LOOK AT PORT
7D73 E67F 00970 AND 7FH ;CLEAR STUFF OFF
7D75 F5 00980 PUSH AF ;STORE COPY
7D76 CD3300 00990 CALL CRT ;WRITE YOURSELF A COPY
7D79 F1 01000 POP AF ;RETRIEVE
7D7A F680 01010 SEND OR 80H ;ADD 7TH BIT
7D7C F5 01020 PUSH AF ;SAVE BYTE
7D7D 210100 01030 LD HL,HI ;RS232 SPACE/START
7D80 CD2102 01040 CALL PORT ;WRITE
7D83 CDA87D 01050 CALL DLY ;4 1 BIT
7D86 0608 01060 LD B,8H ;8 BITS + STOP
7D88 37 01070 SCF ;+ STOP BIT
7D89 F1 01080 BITO POP AF ;GET BYTE
7D8A 1F 01090 RRA ;PUT BIT IN CARRY
7D8B F5 01100 PUSH AF ;SAVE
7D8C 3005 01110 JR NC,ZERO ;CARRY=0
7D8E 210200 01120 LD HL,LOW ;CARRY=1,RS232 MARK
7D91 1803 01130 JR OUT ;OUTPUT
7D93 210100 01140 ZERO LD HL,HI ;CARRY=0,RS232 SPACE
7D96 CD2102 01150 OUT CALL PORT ;WRITE
7D99 CDA87D 01160 CALL DLY ;4 1 BIT
7D9C 05 01170 DEC B ;COUNT DOWN
7D9D 20EA 01180 JR NZ,BITO ;LOOP OUT BYTE
7D9F F1 01190 POP AF ;CLEAR STACK
7DA0 C3297D 01200 JP REC V ;BACK
; 01210 ;
; 01220 ;
; 01230 ;
7DA3 217A00 01240 DBOUN LD HL,T1 ;2 MS
7DA6 1803 01250 JR LOOP ;DO IT
7DAB 216702 01260 DLY LD HL,LBD ;110
7DAC 2B 01270 LOOP DEC HL ;COUNT
7DAD 7C 01280 LD A,H ;MSB
7DAE B5 01290 OR L ;LSB
7DAE 20FB 01300 JR NZ,LOOP ;MORE?
7DB0 C9 01310 RET ;DONE
0000 01320 END

```



# New Version of BASIC

*Microsoft's BASIC-80 is designed for Z-80 and 8080 microprocessors.*

From Microsoft comes an upgraded disk BASIC, BASIC-80, designed for the 8080 and Z-80 microprocessors. There are three versions: 8K, extended and disk. Though different system versions with minor variations are available, only the CP/M disk version of BASIC-80, called MBASIC, is reviewed here. For users of the old (version 4.51) MBASIC disk BASIC, most features of the new (version 5.03) MBASIC/BASIC-80 will be familiar (see Tables 1 and 2); but major features have been added! These improvements should please CP/M users who long for the subtleties found in a compiler such as CBASIC.

This review illuminates some less-used functions and commands of MBASIC/BASIC-80, and acquaints the reader with the expanded new features of the new CP/M version.

One interesting feature is the *protect option*. One possible reason that programmers use a compiler, especially in develop-

ing commercial programs, is because the resulting object code is difficult or impossible to modify. Hence, their program is not as subject to plagiarism. MBASIC/BASIC-80 has eliminated this one objection by including a new feature that protects the saved program source code from discovery. Once developed, the source program can be saved in a "protected" mode that only allows it to be run, not edited or listed. Not even executing the program with the old version of MBASIC will reveal its secrets.

This protected mode is entered by the command `SAVE <program name>,P`. This apparently places a direct statement, without line number, at the front of the program, thus faulting the list interpreter. Since it is also saved in an encoded binary format, its contents are further obscured. It cannot be "re-SAVEd" in an ASCII format and examined. Once in the protected mode, it appears to be there permanently. This requires that the original source listing or file be maintained in the unprotected mode in case any adjustments are necessary at a later date.

## New MBASIC/BASIC-80 Commands

The `CALL` statement calls an assembly-language subroutine at a certain address and passes a list of arguments to the subroutine.

The `CHAIN` statement allows interaction between the current program and another. The program can be "merged" with another, and all or part of the variables of the current program can be passed on to the new program. If only part of the variables are passed, the `COMMON` statement must be used to indicate which ones.

`OPTION BASE` declares the minimum value for array subscripts. The minimum value defaults to zero but can be assigned to one with the statement `OPTION BASE 1`.

`RANDOMIZE (RND)` reseeds the random number generator. If not used, the `RND` function will give the same random numbers sequence every time the program is executed. Interesting about its use is the automatic prompt asking for a "Random Number Seed (0-65529)" prior to executing the statement; it might improve the chance

factor in your next game or simulation. The `RND` function no longer requires use of an argument (e.g., `RND(34)`). If none is supplied, it will assume a positive argument.

The `WHILE <expression> . . . (loop statements) . . . WEND` statement acts as a giant conditional statement. As long as the expression is not zero, the loop statements will continue to execute (see Example 1). When the program encounters `WEND`, it returns to `WHILE`, and the expression once again is checked for zero. If a zero expression is found, the program resumes with the next statement following `WEND`. Nesting of the `WHILE/WEND` statement may occur at any level; the programmer must remember that each `WEND` will match the most recent `WHILE`.

The last two new statements correct an inconvenience with the old MBASIC. The `WRITE` statement in new MBASIC outputs data at the terminal. Written as `WRITE <list of expressions>`, it is equivalent to a `PRINT` command, except that it prints commas between items in the expression list. The `WRITE#` command plays a more significant role by automatically overcoming the problem of writing two or more string expressions to a sequential disk file. Consider the following:

```
Let A$ = "Personal"
Let B$ = "Computer"
```

`PRINT#1,A$;B$` writes "PersonalComputer" to the disk with no separation of the `A$` and `B$` string variables. If delimiters such as `PRINT#1,A$,"";B$` are used, proper order is maintained and the separated variables may be detected by an `INPUT#` command. `WRITE#` handles the problem for you.

Some arithmetic manipulations that have been changed will affect programming. The conversion from floating-point to integer values results in rounding instead of truncation. Thus, `C% = 4.5` results in `C% = 5`, where `%` represents an integer variable.

The body of a `FOR . . . NEXT` loop is skipped if the initial value of the loop times the sign of the step exceeds the final value times the sign of the step (see Example 2). The final value for the loop variable is always set before the initial value is set . . . the opposite of old MBASIC.

|                     |               |
|---------------------|---------------|
| AUTO                | LPRINT USING  |
| CLEAR               | LSET,RSET     |
| CLOSE               | MERGE         |
| CONT                | MID\$         |
| DATA                | NAME          |
| DEF FN              | NEW           |
| DEF INT/SNG/DBL/STR | NULL          |
| DEF USR             | ON ERROR GOTO |
| DELETE              | ON...GOSUB    |
| DIM                 | ON...GOTO     |
| EDIT                | OPEN          |
| END                 | OUT           |
| ERASE               | POKE          |
| ERR & ERL variables | PRINT         |
| ERROR               | PRINT USING   |
| FIELD               | PRINT#        |
| GET                 | PRINT USING#  |
| GOSUB...RETURN      | PUT           |
| GOTO                | READ          |
| IF...THEN...ELSE    | REM           |
| IF...GOTO           | RENUM         |
| INPUT               | RESTORE       |
| INPUT#              | RESUME        |
| KILL                | RUN           |
| LET                 | SAVE          |
| LINE INPUT          | STOP          |
| LINE INPUT#         | SWAP          |
| LIST                | TRON/TROFF    |
| LLIST               | WAIT          |
| LOAD                | WIDTH         |
| LPRINT              |               |

Table 1. Continued commands and statements.



|               |          |
|---------------|----------|
| ABS           | MID\$    |
| ASC           | MKI\$    |
| ATN           | MK\$     |
| CDBL          | MDS\$    |
| CHR\$         | OCT\$    |
| CINT          | PEEK     |
| COS           | POS      |
| CSNG          | RIGHT\$  |
| CVI, CVS, CVD | RND      |
| EOF           | SGN      |
| EXP           | SIN      |
| FIX           | SPACE\$  |
| FRE           | SPC      |
| HEX\$         | SQR      |
| INP           | STR\$    |
| INSTR         | STRING\$ |
| INT           | TAB      |
| LEFT\$        | TAN      |
| LEN           | USR      |
| LOC           | VAL      |
| LOG           | VARPTR   |
| LPOS          |          |

Table 2. Continued functions.

Division by zero and overflow no longer produce a program crash, as did old MBASIC. Instead, "division by zero" error message and machine infinity are printed, and the program continues to execute. However, if data from the errant calculation is important, an error trap may be necessary to save it or the logic of the program.

The rules for printing single-precision and double-precision numbers have been changed in new MBASIC. If the argument to ON...GOTO is out of range, an error message results and execution halts. Old MBASIC would probably have executed one of the arguments.

The CLEAR statement sets the highest memory location available for use by MBASIC/BASIC-80—needed to reserve space at the top of memory for assembly-language programs—and for setting aside stack space for BASIC. Unlike old MBASIC, which required declaration of string space beyond where a default occurred, the new BASIC allocates string space dynamically. If the CLEAR statement is omitted entirely, BASIC still finds room for that large word-processing file. An error occurs only when no free memory remains for MBASIC/BASIC-80 use.

A minor inconvenience is the new way of handling an INPUT statement. If a value has already been assigned to a variable, you cannot merely press RETURN to pass the assigned value to the same INPUT variable. It will not "fall through." A specific value must be given for the INPUT requested or an error message is printed. This more precise way of dealing with this command seems typical of the new philosophy regarding upgrading of this BASIC.

Two editing characters have been freed for special use with PRINT USING. The ampersand is used for variable length string fields, and the underscore demarks a char-

acter in a format string. Except as noted above, the ampersand is just another character that will no longer restart a current line.

The WIDTH statement, when written as Width 255, makes the line width infinite: no carriage return is issued at the end of a "normal line." This suggests an easy way of developing a self-managing text editor. The default width is still 72 characters.

BASIC will now recognize variable names up to 40 characters, as opposed to only two in old BASIC, and these may contain embedded reserved words. Because of this expanded capability, you cannot write a "compressed" BASIC program: ONDGOTO-100, 200,300ELSEPRINT "Not valid":GOTO-45, for example. Any program read from a disk in the compressed form produces an error. The solution is to expand the code so that a space exists between command and variable. A drawback is that you then lose the memory savings of the tighter code.

The INPUT\$(X) function returns a string of X characters read from the terminal. Related in function to the INP function, INPUT\$ allows entering data without echoing characters to the video display (see Example 3). It also conveniently handles string input without requiring a RETURN key. The argument X is the number of characters examined on input, not a port number assignment. The format INPUT\$(X,#Y) allows data to be read from file #Y.

#### Oldies but Goodies

Several little-used but interesting functions are retained in new MBASIC, which, with minor exceptions, is compatible with the 4.51 version. Some of these functions are rarely seen in published programs, either because the casual programmer is unfamiliar with them or because he is attempting to make his program "universal." Some of these functions operate at the CPU level, so you can gain speed using them. Consider the following:

STRING\$(n,m[X\$]). This function returns a string of length n whose characters all have ASCII code m or the first character of X\$. It prints a single character on the screen about twice as fast as a FOR...NEXT loop. To test this speed, compare the programs in Example 4.

VAL(X\$). This function returns the numerical value of string X\$. In Example 5, this allows use of consistent escape or interrogation commands, while permitting

use of a convenient statement such as ON...GOTO. Thus, either a string or numeric response may be made.

INSTR ([I,] X\$,Y\$). Seeks the first occurrence of string Y\$ in X\$. An optional offset I sets the starting position of the search. Like STRING\$, this function operates in CPU and returns a rapid reply in the form of a position number showing where Y\$ begins within X\$. This position number can be used as a switch to identify the presence or absence of a string. If one is present, the number returned will be greater than zero. The number can also be used with the TAB function to mark or underline a specific portion of the main string. Without this, you are obligated to use the much slower MID\$ function.

INP(I). The first byte read from port I is returned; thus, information from/to a port may be detected. This can lead to an instantaneous response by the computer when a key is pushed; no RETURN is needed. Consider Example 6. A fairly standard terminal configuration, status port = 0; data port = 1, is used.

If all works correctly, pressing the E key will cause formation of a loop in which END PROGRAM is printed. Pressing any other key breaks the loop, and the program starts again. This technique might be valuable for people not familiar with computer operation. When a prompt says PRESS Y OR N

```
150 SWITCH=1: REM SET TO "NOT-ZERO"
160 WHILE SWITCH
170   INPUT "Name ",N$
180   IF N$="QUIT" THEN SWITCH=0
190 WEND
200 PRINT:PRINT "Name list is done"
```

Example 1. WHILE/WEND statement.

```
10 X=0
20 FOR Y=1 TO X
30 PRINT Y
40 NEXT Y
```

| Old MBASIC | New MBASIC |
|------------|------------|
| RUN        | RUN        |
| 1          | Ok         |
| Ok         |            |

Example 2. The FOR...NEXT loop no longer "falls through."

```
10 PRINT "Welcome - what is your PASSWORD?"
20 P$=INPUT$(3)
30 IF P$="JON" THEN PRINT "You may proceed"
40 GOTO 20
```

Example 3. A use of INPUT\$.



```

A.      10 C=1
        20 PRINT STRING$(70,ASC("-"))
        30 C=C+1: IF C=21 THEN STOP
        40 GOTO 20

B.      10 FOR X=1 TO 20
        20 FOR Y=1 TO 70:PRINT "-";:NEXT Y
        30 NEXT X

```

*Example 4. Program A will execute at almost twice the speed of program B.*

```

100 PRINT "Account numbers --- 1"
110 PRINT "Names ----- 2"
120 PRINT "Addresses ----- 3"
130 INPUT P$
140 IF P$="END" THEN 2000: REM RETURN TO MAIN MENU
150 IF P$="?" THEN 3000: REM GET HELP
160 ON VAL(P$) GOTO 500,700,900
170 GOTO 100

```

*Example 5. Both string and numeric variables can be handled by use of the VAL statement.*

and the person does, the computer becomes more interactive.

**ERROR.** Microsoft has continued with a liberal array of error traps. These become increasingly important as the program becomes more sophisticated. In Example 7, if the equation in line 660 has a zero for the denominator, line 650 has allowed for this by causing a branch to line 670, where the line number and type of error are identified. In this manner, the program will continue to operate and handle the predicted error any way the programmer chooses.

**SWAP X,Y.** This command exchanges values of two variables. As long as they are the same type, variables may be switched. SWAP X,Y assigns the value of X to Y and vice versa. It is handy in sorting routines.

**DISK INPUT/OUTPUT.** MBASIC/BASIC-80 supports both sequential and random files. Programs are stored on disk by using SAVE "filename" [A]. Normally these programs are saved in a compressed binary format, which results in a savings in disk memory and increased speed in loading. In order to perform certain manipulations, however, it is sometimes necessary to save a program in ASCII format. Using the [A] option after the filename easily accomplishes this.

To load a program from disk into memory, type LOAD "filename." Though present in memory, the program will not execute unless a RUN is typed or the program is loaded with the [R] option after the filename. You can also use RUN "filename" to load and execute the program. Both commands may be placed within a program and executed from there. While data files can be kept open during chaining of programs, all variable values are reset to zero. To preserve these values, the CHAIN command must be used (see above).

To delete a file from the disk, type KILL

"filename." To change the file name, type NAME "oldname" AS "newname." Both KILL and NAME can operate on all file types. If you desire the "protect" option, use the [P] option (e.g., SAVE "filename",P).

Sequential files are supposed to be easier to create than random files, but once the basic procedure is understood, both sequential and random filing may be easily implemented. Sequential files are first OPENed and data PRINT#ed onto the disk by one of the following statements: PRINT#, PRINT # USING, WRITE#. When the operation is completed and further disk activity is not anticipated, the file must be CLOSED. To read data into memory from disk, the file is again OPENed and read by the INPUT# or LINE INPUT# statements. Normally it is necessary to detect the end-of-file (EOF) to avoid attempting to read past the file, in which case an error results.

To increase disk I/O speed and manipulation of data, you must use random files, which use less memory because of the way the files are stored in disk (packed binary format), unlike sequential files (ASCII). You can directly access specific data without having to sequentially input and examine it. This is, perhaps, the greatest advantage of random file I/O.

A file is OPENed, as with sequential filing, but the additional information must be supplied to direct the computer to look toward the random buffer. The statement LSET (or RSET) is used for this purpose, and a PUT# statement deposits the data into the specified record. The file should be closed as soon as data transfer is completed. Reading data out from the disk into memory is the reverse of the process. The file must be opened and the computer FIELDed—space is allocated for the incoming data. A GET# statement plus record number moves

the data into the designated memory location. This process involves more program code than a sequential file.

A new feature of random file I/O is the variable record size. Formerly a record size on a disk was 128 bytes, whether or not that many bytes had been set aside in the buffer during the data-saving process. It was possible to utilize "dummy" variables to allow writing in only part of the record space. While this increased the efficiency of data allocation, it did not change the 128-byte record length.

Now, the statement OPEN "R",1,"ACCT",21 opens file number 1 of a file named "ACCT" and restricts the record space on the disk to 21 bytes. Without this last number, the record size defaults to 128 bytes, the only record size in the old BASIC. This simple allocation saves disk space.

## Summary

Microsoft's BASIC-80 is fast and efficient, and contains significant new features. In terms of memory, it costs the user 5858 bytes, the increased size over the former version. The expanded functions and enhancements on which programmers must rely to ease their work, however, seem worth the increased overhead. The documentation accompanying the language is clear and explicit. The various improvements suggest a more precise BASIC, more structured than before. Sixteen-digit double-precision math is allowed as well as sequential and random filing. Interaction between other programs via chaining should boost the use of modular programming, increasing the throughput of larger segmented programs. The "protect" mode should encourage commercial program development. The advantages of BASIC-80 should please any user. ■

```

10 WAIT 0,1,1
20 A=INP(1): REM A = DECIMAL EQUIVALENT BYTE AT PORT 1
30 IF A>127 THEN A=A-128
40 IF A=ASC("E") THEN PRINT "END PROGRAM":GOTO 20
50 IF A=ASC("C") THEN PRINT "THIS PROGRAM WILL CONTINUE"
60 GOTO 10

```

*Example 6. Spontaneous response is possible using INP.*

```

650 ON ERROR GOTO 670
660 C1=((FNS(R1)-FNS(T1)*FNC(D)))/(FNC(T1)*FNS(D))
670 IF ERR=11 AND ERL=660 THEN RESUME 430

```

*Example 7. Error trap for a division by zero. Note that even if no trap is used, the program will still execute; but any data from the equation will be lost. Trapping helps control data flow.*



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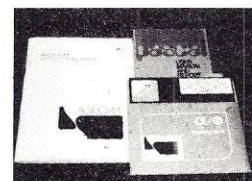
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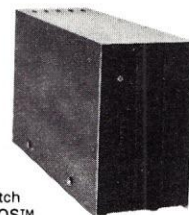
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# Hashing Revisited

*Turn your names into numbers and store and retrieve them with ease.*

Raymond T. Vizzone  
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I had been four months since I last argued with my partner about the merits of hashing. In fact, I had introduced this technique to him, but was unable to convince him that it was the best way to store and retrieve data on disk or in arrays. He didn't like the disadvantages of rehashing—collision, wasted space and overhead. Neither did I! I couldn't blame him for ignoring me as he went back to his sorts and binary searches. I temporarily gave up.

While reading a book called *Compiler Construction for Digital Computers* by David Gries, I came across hashing again. At the same time, I also discovered some similarities existing between how Gries and Donald Fitchhorn ("DOCUMENT," *Kilobaud*, August 1978, p. 22) used hashing methods. With a little more research, I was ready to approach my partner with confidence.

Being subtle, I told my partner that hashing was the only way to retrieve data quickly. That was an absolute statement. He ignored me. I continued, none-

theless, and claimed hashing involves no sorting or binary or sequential searches. He had heard that song-and-dance before and was still waiting for more explanation. I emphasized that data is stored in memory sequentially as it is entered, never needing to be moved. Data is always available for quick retrieval with no need for rehashing. That did it! I had him now.

## Implementing HASH-IT

In explaining the hashing method shared by both Gries and Fitchhorn, I used pictorials and illustrative examples. In the beginning, I proposed a function called HASH-IT, which would change names (KEYS) into numeric values called HASH-VALUES. The process is shown in Fig. 1. The function HASH-IT can be any method of converting an alphanumeric KEY to an integer numeric.

In using HASH-IT, each HASH-VALUE produced points into an array called the HASH TABLE (HT). For example, a HASH-VALUE of 3 is shown in Fig. 2. In turn, the contents of each element of the HASH TABLE point to an element of the STORAGE ARRAY (SA), which holds the data and their

respective KEYS (see Fig. 3).

I needed to implement two other concepts to fully explain the madness of this method. I wanted a pointer to show me where the next empty location of the STORAGE ARRAY was. For convenience, I called this pointer EMPTY. I made the STORAGE ARRAY two-dimensional to facilitate a linked-list affair. The use of this linked list will become clear in later examples. Fig. 4 shows a general pictorial of everything I needed to explain this hashing method.

To demonstrate this hashing method using Fig. 4, I used six names to "hash-in" to the STORAGE ARRAY. The first name was JOHNSON, which hashed to a numeric value of 3. The numbered location pointed to by EMPTY was then stored in the HASH TABLE at location 3. JOHNSON was stored in the STORAGE ARRAY at the location that EMPTY pointed to before being incremented (see Fig. 5). The names SMITH and

JONES hashed to values of 6 and 1, respectively. Figs. 6 and 7 show how they were handled.

## Rehash

The demonstration was going

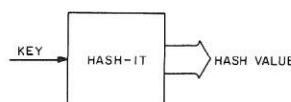


Fig. 1. HASH-IT function.

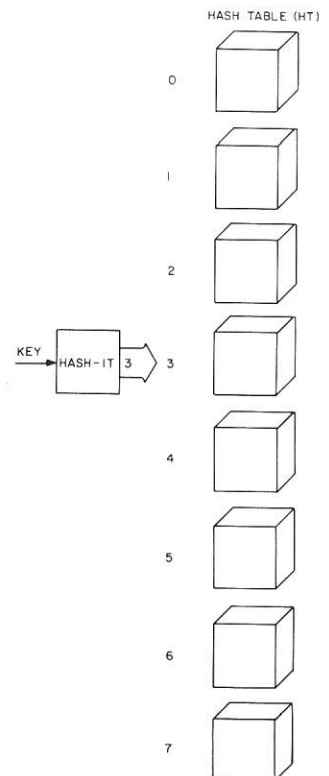


Fig. 2.





well, and my partner was still with me. All three names had hashed to different numeric values. So far, so good. I used the name MURPHY next and found it hashed to a value of 3. So had JOHNSON! This was a collision, and I had promised I

wouldn't rehash or recalculate the HASH VALUE in order to find an empty element in the HASH TABLE. So now I had to use that second row of the STORAGE ARRAY.

MURPHY was stored at the next location in the STORAGE

ARRAY pointed to by EMPTY. This location was 3, the sequential element after JONES. Normally, this value of 3 would be stored in the HASH TABLE at the location pointed to by the HASH VALUE. However, in this case, there was already a number there, more specifically, the pointer to JOHNSON. I couldn't disrupt this arrangement because I would not be able to find JOHNSON again! So I stored the value pointed to by EMPTY in the second row of the STORAGE ARRAY element containing JOHNSON.

To find MURPHY later would first require hashing it to a value of 3 (see Fig. 8). A look into the HASH TABLE at location 3 would find a pointer value of zero. The contents of the "zeroth" element of the STORAGE ARRAY would produce JOHNSON. JOHNSON would not be MURPHY by any means, so a further look would find that the link attached to JOHNSON pointed to the third element of the STORAGE ARRAY. Further investigation would find that MURPHY resided at this third element of the STORAGE ARRAY, and the search would be done.

The name DOE was next and

gave me no trouble. It quietly hashed in and was stored as shown in Fig. 9.

JAMES was not so easy. It, too, hashed to a value of 3, right in there with JOHNSON and MURPHY. As handled before, the links were changed, and JAMES joined the group (see Fig. 10).

### The Program

The program listed demonstrates the preceding pictorials and procedures. Its design is to provide a set of utility procedures to be used in other programs. The sections called HASH-IT and HASH-IN correspond to the figures above. I wrote them to simulate the ability to pass and receive parameters between procedures. Both procedures can be extracted and used in other programs.

The only change to make before HASH-IN can be truly considered general is to delete lines 520 through 524 and lines 527 and 529. These were written to facilitate the deletion ability of the program. HASH-IT is general and, as listed, will return a HASH VALUE (HASHV) for a given N\$ not equal to a null string (""). The length of the HASH TABLE (LHT) must be given in

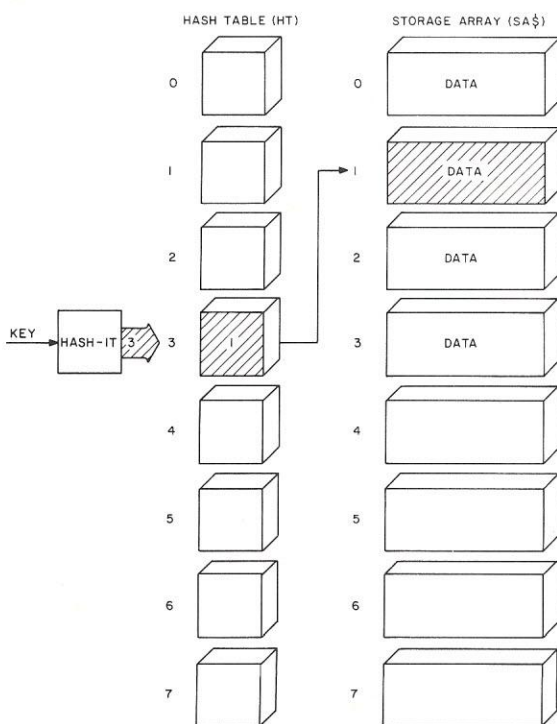


Fig. 3.

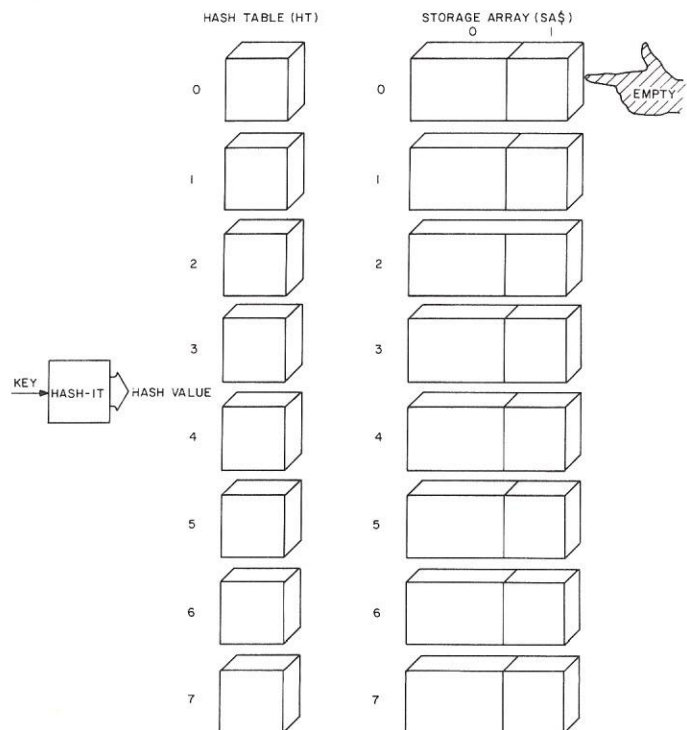


Fig. 4.



line 2120.

HASH-IT was developed by my partner, Mike Smith, to produce hash values from any length keys. His method first calculates the length of the key N\$. Then, in lines 2050-2100, the ASCII values of every character

in N\$ are cumulatively added. Starting with the first character, every other character of N\$ is added and stored in variable A(0). Simultaneously, every other character, starting with the second character of N\$, is added and the sum stored in

variable A(1).

This forms two separate numbers that are divided by 256, and their remainders are saved. The remainder from A(1) is multiplied by 256 and added to the remainder from A(0). The HASH VALUE is then made

equal to this number divided by the variable LHT—the prime number size of the HASH TABLE. This all takes place in lines 2110-2120.

### Uses

The program accepts and

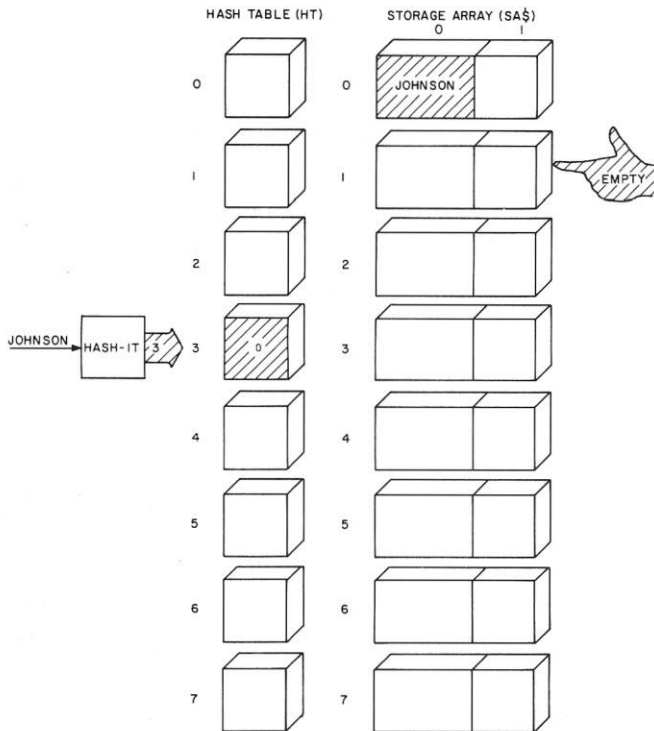


Fig. 5.

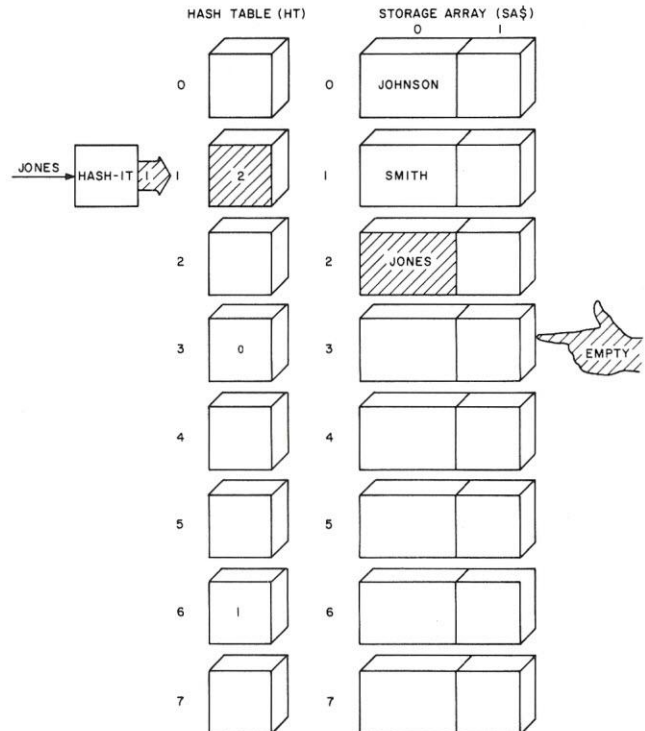


Fig. 7.

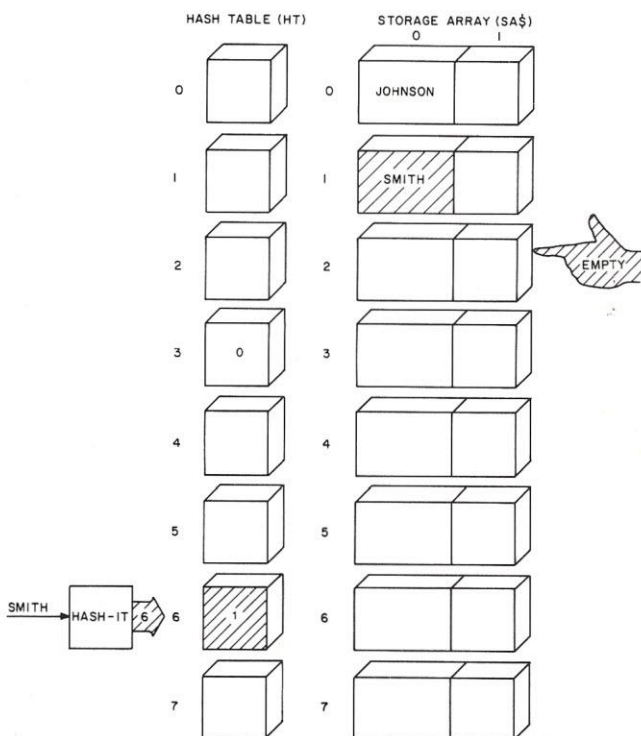


Fig. 6.

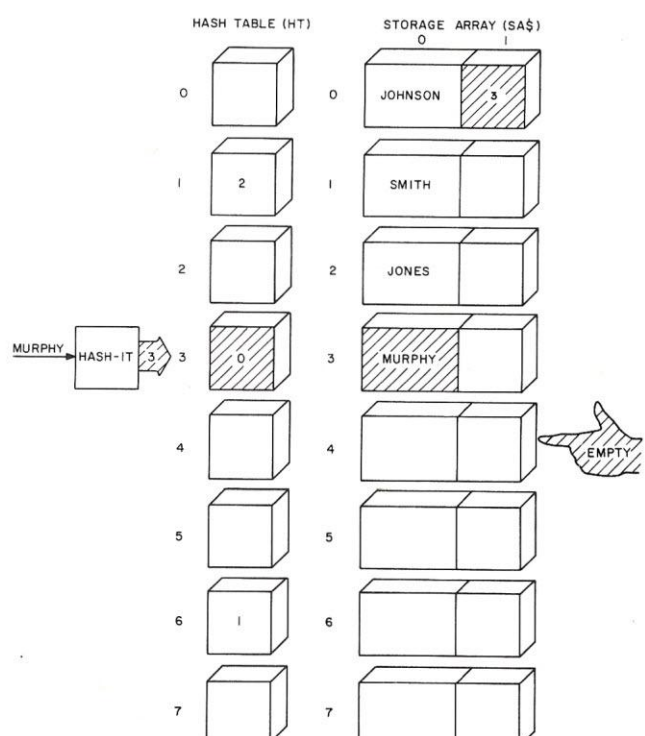


Fig. 8.



stores keys called SUBJECTS. Along with each SUBJECT, a 256-character miscellaneous field can be stored for later retrieval. One use of this program is to store names and phone numbers. The quick retrieval process used makes it

a lot faster than your telephone book. Another idea is to provide an information network affair for clubs or others organizations. When members want to store subjects with information, they can use the ADD command. Then when members

need to know further information about any subject, a query into the computer may find the desired information.

Quick retrieval and large storage capabilities make this sort of information mill a good application for a microcomputer. For a large data base, the addition of a data-save procedure can be added. A disk file can be substituted for the

STORAGE ARRAY also.

## Conclusion

This program can be used as is, or modified for more complex applications. The concept of hashing itself is in use with compilers and in DOCUFORM. Its explanation is intended to add another method of data storage and retrieval to a programmer's bag of tricks. ■

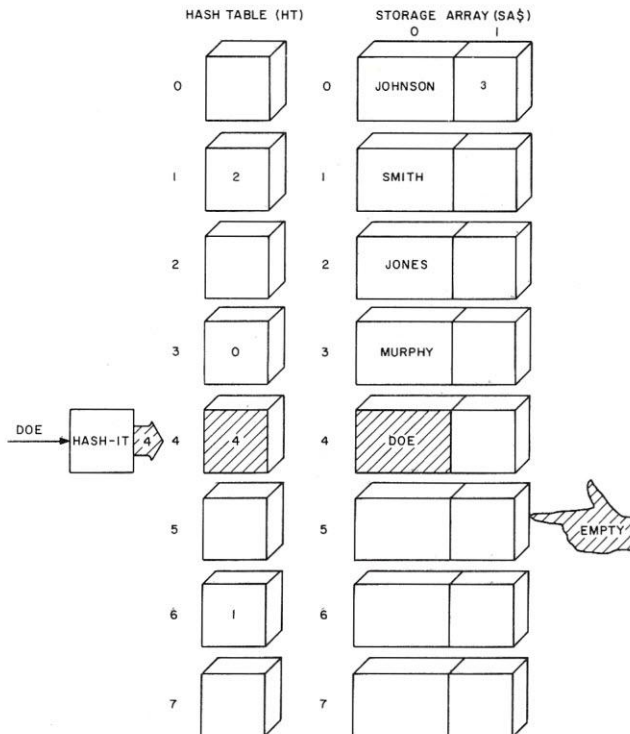


Fig. 9.

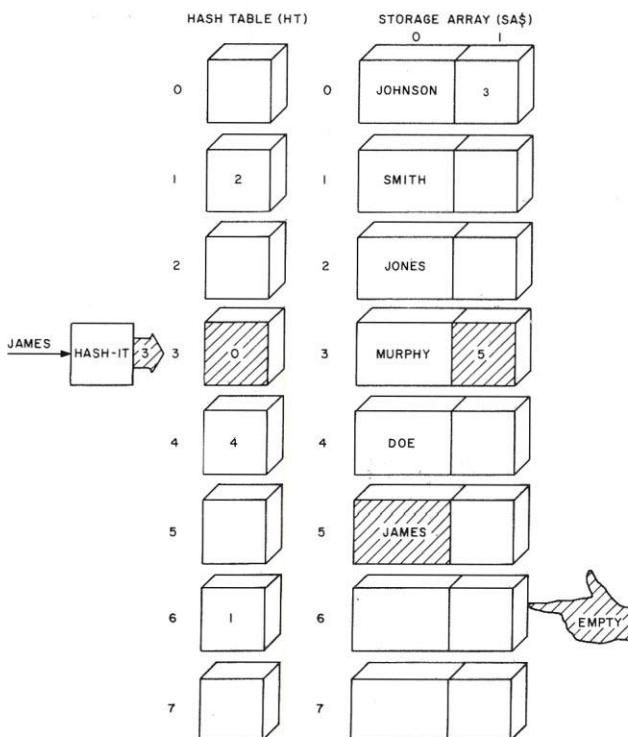


Fig. 10.

## Program listing.

```
0 CLEAR : REM
      INFORMATION MILL
1 REM
2 REM : WRITTEN BY R.T. VIZZONE 1979 CREATIVE CONSULTING
3 REM : FOR THE APPLE II COMPUTER (REQUIRES APPLESOFT)
4 REM
5 REM
6 REM
7 REM : MAIN PROGRAM
8 REM
9 REM
10 GOSUB 100: REM      INITIALIZE
20 GOSUB 800: REM      MENU
30 ON SEL GOSUB 300,900,1100,3000,1000,700
40 IF EXIT THEN 60
50 GOTO 20
60 END
70 REM
90 POKE 32,8: POKE 33,20: POKE 34,7: POKE 35,24: PRINT : RETURN
100 REM
110 REM : INITIALIZE
120 REM
125 LHT = 101: LSA = 100: REM      DEFINE LENGTHS OF HASH TABLE AND STORAGE ARRAY
130 DIM HT(LHT),SA$(LSA,2)
140 FOR I = 0 TO LSA
150 :SA$(I,0) = "-1"
160 :SA$(I,1) = "-1"
170 NEXT I
180 FOR I = 0 TO LHT
190 :HT(I) = -1
200 NEXT I
205 NLOC = -1:TR = -1
220 DEF FN FOUND(A) = A + 1
230 RETURN
240 REM
250 REM : ADD
260 REM :
270 REM :
280 HOME
290 REM      IS SA# FILLED#
300 IF (TR < LSA) THEN 340: REM      NO IT'S NOT - CONTINUE
310 REM      YES IT IS! QUIT
320 VTAB(10): PRINT "NOT ENOUGH ROOM FOR AN ADD."
330 VTAB(12): PRINT "PRESS ANY KEY TO CONTINUE": GET A$
339 GOTO 370
340 VTAB(5): INPUT "SUBJECT: ";N$
345 IF N$ = "" THEN 370: REM      IF USER QUIT THEN RETURN
347 VTAB(7): PRINT "INFO: "
348 PRINT
350 GOSUB 90: VTAB(7): HTAB(1): INPUT " ";MISC$: TEXT
355 ADD = 1: REM      HASH-IN(N$,1,RN)
360 GOSUB 400
365 TEXT : HOME : VTAB(12): PRINT "THANK YOU"
367 FOR I = 1 TO 500: NEXT I: REM      WAIT TO READ THANK YOU NOTE
368 TR = TR + 1: REM      INCREMENT TOTAL RECORDS VARIABLE (TR)
370 RETURN
380 REM
400 REM
410 REM : HASH-IN(N$,ADD,RN)
420 REM : GIVEN N$=NAME &
430 REM : ADD=0 OR 1
440 REM : RETURN RN=RECORD #
450 REM
455 REM
457 GOSUB 2000: REM      HASH-IT(N$,HRSV)
460 COLLISIE = 0: REM      COLLISION FLAG
470 P1 = HASHV: REM      P1 NOW POINTS INTO THE HASH TABLE.
480 P2 = HT(P1): REM      LOOK IN HASH TABLE
485 REM      ARE LOCATION CONTENTS EMPTY?
```



```

490 IF P2 < > - 1 THEN 600: REM NO - GO CHECK SA# POINTED TO BY P2
500 IF ADD THEN 520: REM YES - DO RN ADD.
510 RN = - 1: GOTO 650: REM YES BUT, THIS WAS A RETRIEVE. RN=-1 FOR A RECORD NOT FOUND. RETURN.
515 REM CHECK TO SEE IF THERE ARE ANY EMPTY LOCATIONS IN SA# MADE BY A PREVIOUS DELETE.
520 IF NOT DFLAG THEN 525
521 FOR I = 0 TO NLOC
522 IF SA$(I,0) = "-1" THEN 529: REM THERE IS ONE - USE IT.
524 NEXT I
525 NLOC = NLOC + 1: REM THERE WASN'T ONE - MOVE THE EMPTY POINTER DOWN.
526 EMPTY = NLOC
527 GOTO 530
529 EMPTY = I: DFLAG = DFLAG + 1: REM USING A PREVIOUSLY DELETED LOCATION DECREMENT TOTAL # OF DELETED LOCATIONS.
530 P2 = EMPTY: REM AT LOCATION POINTED TO BY EMPTY...
540 SA$(P2,0) = N#: REM ... STORE KEY.
545 SA$(P2,2) = MISC#: REM ATTACH ITS MISC INFO.
560 IF COLLISIEN THEN SA$(P1,1) = STR$(EMPTY): REM THIS IS A COLLISION-ADD - CHANGE POINTERS.
570 IF NOT COLLISIEN THEN HT(P1) = EMPTY: REM THIS A NO COLLISION-ADD.
580 GOTO 650: REM ADD DONE - RETURN.
590 REM LOOK IN SA# FOR A MATCH
600 IF SA$(P2,0) = N# THEN 640: REM A MATCH - RETURN.
610 P1 = P2: COLLISIEN = 1: REM NO MATCH. SET COLLISION FLAG AND.
620 P2 = VAL (SA$(P1,1)): REM CHECK THE 2ND COLUMN OF SA# FOR NEXT LOCATION TO SEARCH.
630 GOTO 485: REM SEARCH AGAIN.
640 RN = P2: REM RN NOW EQUALS THE LOCATION IN SA# OF KEY JUST ADDED OR FOUND.
650 ADD = 0
660 RETURN
700 REM .....
710 REM ..... EXIT .....
720 REM .....
730 REM
740 EXIT = 1
750 RETURN
800 REM .....
810 REM ..... MENU .....
820 REM .....
830 HOME
840 VTAB (5): PRINT "SELECTION MENU"
850 VTAB (10): PRINT "1. ADD A SUBJECT"
860 VTAB (12): PRINT "2. FIND A SUBJECT"
870 VTAB (14): PRINT "3. DELETE A SUBJECT"
875 VTAB (16): PRINT "4. LIST ALL SUBJECTS"
879 VTAB (18): PRINT "5. UPDATE A SUBJECT"
880 VTAB (20): PRINT "6. EXIT PROGRAM": PRINT : PRINT
890 PRINT "INPUT SELECTION NUMBER PLEASE: ";
892 GET SEL$
894 SEL = VAL (SEL$)
896 IF SEL < 1 OR SEL > 6 THEN 830
898 RETURN
900 REM .....
910 REM ..... RETRIEVE .....
920 REM .....
930 REM
940 HOME
950 VTAB (5): INPUT "SUBJECT: "; R$
955 IF R$ = "" THEN 999: REM USER QUILTS
960 ADD = 0: N# = R$: GOSUB 400: REM HASH = IN(R$, 0, RN)
960 IF FN FOUND(RN) THEN 990
982 VTAB (12): PRINT "I CAN'T FIND IT. PRESS ANY"
983 PRINT "KEY TO GO ON. "; GET A#
984 GOTO 999: REM RETURN
990 VTAB (7): PRINT "INFO: "
993 GOSUB 90: VTAB (7): HTAB (2): PRINT SA$(RN,2): TEXT
994 VTAB (24): PRINT "PRESS ANY KEY TO GO ON. ";
995 GET A#
996 VTAB (24): HTAB (1): CALL - 868

```

```

999 RETURN
1000 REM .....
1010 REM ..... UPDATE .....
1020 REM .....
1030 REM
1040 GOSUB 900: IF NOT FN FOUND(RN) OR R$ = "" THEN 1070: REM IF USER QUIT OR NOT FOUND THEN RETURN
1041 VTAB (23): HTAB (1): CALL - 868
1042 GOSUB 90
1047 VTAB (7): INPUT MISC#: REM DISPLAY MISC INFO. UPDATE WITH CURSOR
1060 SA$(FOUND,2) = MISC#
1070 TEXT : RETURN
1100 REM .....
1110 REM ..... DELETE .....
1120 REM .....
1130 REM
1140 GOSUB 900: REM FIND RECORD REQUESTED
1145 IF R$ = "" THEN 1200: REM IF USER QUIT OR...
1147 IF NOT FN FOUND(RN) THEN 1200: REM RECORD NOT FOUND THEN RETURN.
1150 VTAB (24): HTAB (1): PRINT "DO YOU WISH TO DELETE THIS INFORMATION?"; GET A#
1160 IF A# = "N" THEN 1200
1170 SA$(RN,0) = "-1": REM ERASE DELETED ENTRY.
1180 FOR I = 1 TO LHT: REM CHECK DELETED ENTRY TO SEE IF...
1185 REM ... IT'S 1ST IN A SERIES OF COLLISIONS. IF SO...
1190 IF HT(I) < > RN THEN 1194: REM ... REPLACE ITS POINTER IN HT WITH ITS COLLISION POINTER FROM ITS 2ND COLUMN.
1192 HT(I) = VAL (SA$(RN,1))
1193 SA$(RN,1) = "-1": GOTO 1195: REM CONSEQUENTLY ERASE ITS 2ND COLUMN.
1194 NEXT I
1195 DFLAG = DFLAG + 1: REM INCREMENT DFLAG TO INDICATE ANOTHER EMPTY LOCATION EXISTS.
1197 TR = TR - 1: IF TR < 0 THEN TR = - 1: REM DECREMENT TOTAL RECORDS, NOT TO BE <-1.
1200 RETURN
2000 REM .....
2010 REM : HASH-IT(N#,HASHV) :
2020 REM : GIVEN N#, RETURN :
2030 REM : HASHV :
2040 REM .....
2042 REM DESCRIBED IN ACCOMPANYING ARTICLE
2045 HASHV = 0
2047 N = LEN (N#)
2050 A(0) = 0: A(1) = 0
2060 FOR I = 1 TO N
2070 :J = INT ((I / 2 - INT (I / 2)) * 2 + .05) * SGN (I / 2)
2080 :A = ASC ( MID$( N#, I))
2090 :A(J) = A(J) + A
2100 NEXT I
2110 HASHV = ( INT ((A(0) / 256 - INT (A(0) / 256)) * 256 + .05) * SGN (A(0) / 256)) + 256 * ( INT ((A(1) / 256 - INT (A(1) / 256)) * 256 + .05) * SGN (A(1) / 256))
2120 HASHV = INT ((HASHV / LHT - INT (HASHV / LHT)) * LHT + .05) * SGN (HASHV / LHT)
2140 RETURN
3000 REM .....
3010 REM ..... LIST ALL .....
3020 REM .....
3030 REM PRINT ALL ELEMENTS OF SA# THAT ARE NOT EMPTY (NOT -1)
3035 HOME
3040 FOR I = 0 TO NLOC
3045 IF SA$(I,0) = "-1" THEN 3090
3050 HTAB (5): PRINT SA$(I,0)
3060 CV = PEEK (37): REM IS SCREEN FULL(I.E. IS CURSOR AT BOTTOM OF SCREEN)?
3070 IF CV < 21 THEN 3090: REM NO - CONTINUE.
3075 PRINT : REM YES - CHECK WITH USER TO CONTINUE.
3080 PRINT "PRESS ANY KEY TO CONTINUE OR 'Q' TO QUIT": GET A#: IF A# = "Q" THEN 3110
3085 HOME
3090 NEXT I
3095 PRINT
3100 PRINT "PRESS ANY KEY TO GO ON "; GET A#
3110 RETURN

```



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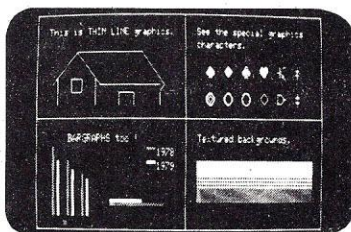
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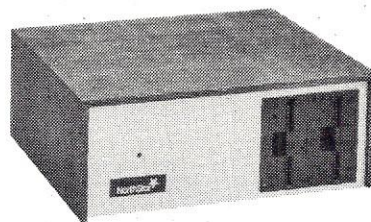
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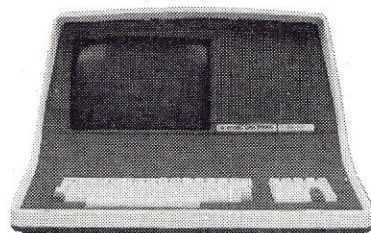
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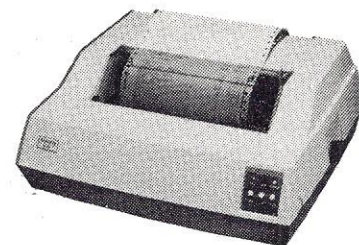


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# 6800 Trace and Disassemble Program

*This program puts you on the trail of runaway routines.*

Richard Carickhoff  
812 Pulaski Dr.  
Lansdale PA 19446

**D**id you ever write a program that didn't work and then spend hours, or even days, debugging it? Did you ever wonder how the program got to that particular location? ... why that compare instruction wasn't working as you thought it should? ... why that multiply routine didn't work?

Well, I've been down that road many times myself, so I decided to write a program that would allow me to trace a program instruction by instruction while, at the same time, see exactly what was taking place before and after the execution of each instruction.

The 6800 Trace and Disassemble program does just that. The program enables the user to perform the following functions:

- Program trace function
- Go to user's program function

- Program disassemble function
- Memory examine and change function
- Register examine and change function

The detailed explanations, along with operating procedures for each of these functions, are described in the following paragraphs.

At the start of each function it is assumed that the last data character printed by the terminal is a colon (:), which is the program's prompt character. All values entered must be in hexadecimal format.

## Program Trace Function

The program trace function will trace the user's program one instruction at a time, while outputting to the terminal the location, mnemonic, operand, contents of all MPU registers (CC, B, A, X, SP) and the next return address in the stack. The trace function will do this for each instruction prior to its execution.

The trace function can be per-

formed by typing one of the following two responses:

: T nnnn  
or  
: T nnnn, mmmm

The first response must be terminated with a carriage return. The character T specifies a trace function. The four hexadecimal digits following T specify the starting address of the first instruction to be traced. This response instructs the program to trace only one instruction (see Example 1).

At this point the trace function waits for the operator to

enter a character. If the character is any character other than the Escape (1B hex), the instruction displayed will be executed and the next instruction will be output to the terminal along with the contents of all the MPU registers (see Example 2).

The contents of the following MPU registers are printed along with each instruction:

cc—Condition code register  
b—B register  
a—A register  
x—X register  
sp—Stack pointer

|               | cc | b  | a  | x    | sp   | rtn  |
|---------------|----|----|----|------|------|------|
| : T 0103      |    |    |    |      |      |      |
| 0103 JMP 0225 | 8F | 19 | FF | 2242 | A049 | 7B05 |

Example 1.

|               | cc | b  | a  | x    | sp   | rtn  |
|---------------|----|----|----|------|------|------|
| : T 0103      |    |    |    |      |      |      |
| 0103 JMP 0225 | 8F | 19 | FF | 2242 | A049 | 7B05 |
| 0225 LDS 22   | CF | 19 | FF | 2242 | A049 | 7B05 |

Example 2.



rtn—First return address at the top of the stack

The contents of the program counter is the location of the instruction to be executed.

With the use of the trace function, the operator can step through his program one instruction at a time. The contents of all the MPU registers are always visible before and after the execution of each instruction. Also, the instruction is always printed before it is executed so the operator can decide whether to terminate the trace at that point (depressing Escape key) or to continue.

The second response to the prompt character is used to trace a program until the breakpoint address is reached. The first four hexadecimal digits define the starting address of the first instruction of the trace sequence. The second four hexadecimal digits following the comma define the breakpoint address. Once the last digit is entered, the program will immediately start tracing the program starting at the start address.

The output format is the same as the single trace function except that the program will continue outputting each instruction until the breakpoint address is reached. At that point the trace function operates in the same manner as the single trace function. That is, depressing the Escape key terminates the trace and depressing any other key executes the last instruction printed and outputs the next instruction. The Escape key is also used to terminate a trace sequence prior to reaching the breakpoint address.

Caution: The trace function traces a program with the use of the software interrupt (SWI). Always terminate any trace sequence using the Escape key. Using the system reset may leave a software interrupt in the user's program.

This method of tracing a program is normally used to determine how a program arrived at a particular location. If a CRT is being used for a terminal, the last 15 instructions executed will still appear on the screen

(assuming the CRT has a minimum of 16 lines). The rate at which the program executes is controlled by the output rate of the terminal being used.

Program A shows an example of the trace function. The program selected is Tom Pittman's 6800 Tiny BASIC. I chose this program because it is well known and is an interesting program to trace. It also demonstrates the visibility of a program using the trace function.

The starting address was set at 0103 hex, which is Tiny BASIC's warm start address. The breakpoint address was set at an address that would not be reached. This allowed me to terminate the program at any point during the trace.

In Program A there are several instructions that are disassembled with asterisks (\*\*\*) for the mnemonic and ROM for the operand. This alerts the operator that the trace function came upon a ROM address that could not be loaded with the software interrupt. The trace function in this case places the software interrupt at the return address. The trace function assumes that routines in ROM are functional and always return via the RTS (return subroutine) instruction.

The ROM address shown in Program A is the MIKBUG output routine (EID1). Examining the contents of the A register prior to executing the output routine shows the character being output. Also, the output is reflected in the trace printout as indicated by the line feed following the first output by Tiny BASIC.

#### Trace Function Restrictions

There are only two restrictions on the trace function. The first is that it will not trace a program that uses a software interrupt, since the software interrupt interferes with the trace function's software interrupt. The second restriction is that the trace function cannot be used to trace itself.

#### Go to User's Program Function

This function allows the operator to execute his program. The operator may specify a breakpoint address in order to

```
:T 0103,0FFF
0103 JMP 0225 C1 19 0D 2242 A07D 022A
0225 LDS 22 C1 19 0D 2242 A07D 022A
0227 JSR 062C C9 19 0D 2242 A07F 0000
062C LDA A #0D C9 19 0D 2242 A07D 022A
062E BSR 0649 C1 19 0D 2242 A07D 022A
0649 CLR 00BF C1 19 0D 2242 A07B 0630
064C JMP 0598 C4 19 0D 2242 A07B 0630
0598 INC 00BF C4 19 0D 2242 A07B 0630
059B BMI 05A7 C0 19 0D 2242 A07B 0630
059D STX BA C0 19 0D 2242 A07B 0630
059F PSH B C0 19 0D 2242 A07B 0630
05A0 JSR 0109 C0 19 0D 2242 A07A 1906
0109 JMP EID1 C0 19 0D 2242 A078 05A3
EID1 *** ROM

05A3 PUL B C0 19 0D 2242 A07A 1906
05A4 LDX BA C0 19 0D 2242 A07B 0630
05A6 RTS C0 19 0D 2242 A07B 0630
0630 LDA B 0111 C0 19 0D 2242 A07D 022A
0633 ASL B C0 03 0D 2242 A07D 022A
0634 BEQ 063E C0 06 0D 2242 A07D 022A
0636 PSH B C0 06 0D 2242 A07D 022A
0637 BSR 0642 C0 06 0D 2242 A07C 0602
0642 CLR A C0 06 0D 2242 A07A 0639
0643 TST 0111 C4 06 00 2242 A07A 0639
0646 RPL 0649 C0 06 00 2242 A07A 0639
0649 CLR 00BF C0 06 00 2242 A07A 0639
064C JMP 0598 C4 06 00 2242 A07A 0639
0598 INC 00BF C0 06 00 2242 A07A 0639
059B BMI 05A7 C0 06 00 2242 A07A 0639
059D STX BA C0 06 00 2242 A07A 0639
059F PSH B C0 06 00 2242 A07A 0639
05A0 JSR 0109 C0 06 00 2242 A079 0606
0109 JMP EID1 C0 06 00 2242 A077 05A3
EID1 *** ROM

05A3 PUL B C1 06 00 2242 A079 0606
05A4 LDX BA C1 06 00 2242 A07A 0639
05A6 RTS C1 06 00 2242 A07A 0639
0639 PUL B C1 06 00 2242 A07C 0602
063A DEC B C1 06 00 2242 A07D 022A
063B DEC B C1 05 00 2242 A07D 022A
063C BNE 0636 C1 04 00 2242 A07D 022A
0636 PSH B C1 04 00 2242 A07D 022A
0637 BSR 0642 C1 04 00 2242 A07C 0402
0642 CLR A C1 04 00 2242 A07A 0639
0643 TST 0111 C4 04 00 2242 A07A 0639
0646 BPL 0649 C0 04 00 2242 A07A 0639
0649 CLR 00BF C0 04 00 2242 A07A 0639
064C JMP 0598 C4 04 00 2242 A07A 0639
0598 INC 00BF C4 04 00 2242 A07A 0639
059B BMI 05A7 C0 04 00 2242 A07A 0639
059D STX BA C0 04 00 2242 A07A 0639
059F PSH B C0 04 00 2242 A07A 0639
05A0 JSR 0109 C0 04 00 2242 A079 0406
0109 JMP EID1 C0 04 00 2242 A077 05A3
EID1 *** ROM
```

Program A.

return to the trace program. This function can be performed by typing one of the following two responses:

: G nnnn

or

: G nnnn, mmmm

The first response must be terminated with a carriage return. The character G specifies a Go function. The four hexadecimal digits following G specify the starting address of the program to be executed (e.g., : G 0103).

The only way to return to the Trace and Disassemble program with this response is through the system monitor.

The second response is used to execute a user's program

until the breakpoint address is reached. The first four hexadecimal digits define the starting address of the program to be executed. The second four hexadecimal digits following the comma define the breakpoint address. Once the last digit is entered, the MPU will start executing the user's program. Once the breakpoint address is reached, the control of the program is returned to the trace function (see Example 3).

The program can be traced from this point one instruction at a time by simply depressing any key other than the Escape key. The trace will operate in the same manner as if a trace function was being performed.



```
: G 0103,022F
022F LDX #0080 C1 00 00 07A1 0000
```

Example 3.

If the program does not reach the breakpoint address and the operator wishes to return to the trace and disassemble program, he must perform a system reset and return through the system monitor. However, the software interrupt still exists at the breakpoint address.

To remove the interrupt and replace it with the original instruction, the Go to User's Program function can be executed where the starting address is set to the breakpoint address. The program will immediately return, displaying the original instruction at the terminal. The operator can then terminate the trace function by depressing the Escape key.

#### Program Disassemble Function

This function allows the operator to disassemble any 6800 program including the Trace and Disassemble program itself. The disassemble function can disassemble one instruction at a time or a sequence of instructions, while outputting to the terminal the location, object code, mnemonic and operand for each instruction.

The disassemble function can be performed by typing one of the following two responses:

```
: D nnnn
or
: D nnnn, mmmm
```

```
: D 0225
0225 9E 22 LDS 22
```

Example 4.

```
: D 0225
0225 9E 22 LDS 22
0227 BD 062C JSR 062C
```

Example 5.

The first response must be terminated with a carriage return. The character D specifies a disassemble function. The four hexadecimal digits following D specify the starting address of the instruction to be disassembled (see Example 4).

At this point the disassemble function waits for the operator to enter a character. If the character is any character other than an Escape, the next instruction in sequence will be disassembled (see Example 5). In doing so, the operator can step through a disassembly of a program one instruction at a time.

The second response is used to disassemble a list of instructions. The first four hexadecimal digits specify the first instruction to be disassembled.

```
: D 0225,0280
0225 9E 22 LDS 22
0227 BD 062C JSR 062C
022A FE 01FE LDX 01FE
022D DF 2A STX 2A
022F CE 0080 LDX #0080
0232 DF C2 STX C2
0234 CE 0030 LDX #0030
0237 DF C0 STX C0
0239 9F 26 STS 26
023B 8D B8 BSR 01F5
023D 8D 07 BSR 0246
023F 20 FA BRA 0238
0241 8C 1066 CPX #1066
0244 20 F3 BRA 0239
0246 CE 0117 LDX #0117
0249 DF BC STX BC
024B 81 30 CMP A #30
024D 24 56 BCC 02A5
024F 81 08 CMP A #08
0251 25 91 PCS 01E4
0253 48 ASL A
0254 97 BD STA A BD
0256 DE 9C LDX BC
0258 EE 17 LDX 17,X
025A 6E 00 JMP 00,X
025C BD 062C JSR 062C
025F 86 21 LDA A #21
0261 97 C1 STA A C1
0263 BD 0109 JSR 0109
0266 86 80 LDA A #80
0268 97 C3 STA A C3
026A D6 2B LDA B 2B
026C 96 2A LDA A 2A
026E F0 01FF SUB B 01FF
0271 82 01FE SRC A 01FE
0274 BD 0542 JSR 0542
0277 96 C0 LDA A C0
0279 27 0F BEQ 028A
027B CE 0293 LDX #0293
027E DF 2A STX 2A
0280 BD 05AD JSR 05AD
```

Program B. Disassemble function.

The second four hexadecimal digits following the comma specify the last instruction to be disassembled.

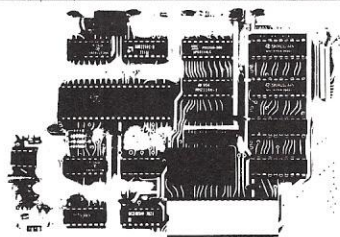
Once the last digit is entered, the program will immediately list each instruction in sequence until the last address is reached. The last address specified must be on an instruction boundary. Otherwise, the disassembly will continue past the

last address. The Escape key can be used to terminate any list sequence.

When the last address is reached, the disassembly will stop. The operator can continue the disassembly one instruction at a time by depressing any key other than Escape. Otherwise, the Escape key will terminate the disassembly and return control back to the control

|   |  |   |  |
|---|--|---|--|
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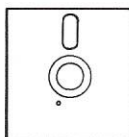
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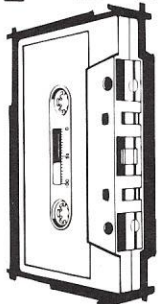
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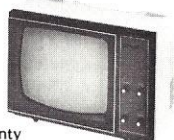
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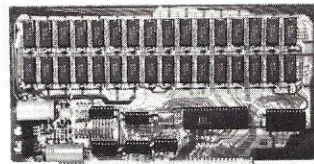
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```

0900 7E E0 CC 7E E0 CA 7E E0 C8 7E E0 7E 7E E1 AC 7E
0910 E1 D1 A0 42 00 00 00 00 0A 7E 00 08 00 0A 00 00
0920 09 00 30 30 30 39 04 30 38 20 20 20 20 20 20
0930 20 49 4E 58 20 20 20 20 20 20 20 20 20 04
0940 00 00 00 00 00 00 00 00 00 00 8E A0 42 BF 09 12
0950 CE 0A E0 FF A0 14 BE 09 12 7F 09 21 CE 08 8A BD
0960 09 09 BD 09 0C 16 BD 09 09 CE 09 2F BD 09 09 BD 0A
0970 78 C1 54 27 27 C1 52 27 06 C1 4D 27 05 20 D7 7E
0980 0A 11 7E 0A 17 BD 09 CE BD 08 A3 CE 09 22 BD 09
0990 09 CE 08 9C BD 09 09 BD 0A 97 20 EC BD 09 CE 30
09A0 B6 09 17 A7 05 B6 09 18 A7 06 BD 08 A3 CE 09 22
09B0 86 04 B7 09 26 BD 09 09 CE 09 2F BD 09 09 BD 0A
09C0 BE CE 08 9C BD 09 09 BD 0A 97 BD 08 11 3B BD 0A
09D0 65 FF 09 17 BD 09 09 BD 0A 97 BD 0A 59 FF 09
09E0 1F 7C 09 21 39 CE 08 9C BD 09 09 39 BD 0A 65 FF
09F0 09 15 30 B6 09 15 A7 05 B6 09 16 A7 06 7F 09 1E
0A00 BD 09 0C 81 0D 27 09 BD 0A 59 FF 09 17 BD 08 11
0A10 3B 30 FF 09 15 20 03 BD 0A 65 CE 08 9C BD 09 09
0A20 CE 09 15 BD 09 06 FE 09 15 BD 09 03 FF 09 15 BD
0A30 09 0C 81 20 27 E4 81 08 26 0A FE 09 15 09 09 FF
0A40 09 15 20 06 BD 0A 81 BD 0A 75 09 A7 00 A1 00 27
0A50 C9 86 3F BD 09 07 FE 09 56 8D 0A CE 08 9C BD 09
0A60 09 FE 09 15 39 8D 0C 87 09 15 8D 07 B7 09 16 FE
0A70 09 15 39 8D 09 48 48 48 48 16 8D 02 1B 39 BD 09
0A80 0C 80 30 2B 0F 81 09 2F 0A 81 11 2B 07 81 16 2E
0A90 03 80 07 39 7E 09 56 7D 09 21 27 0D FE 09 17 BC
0AA0 09 1F 26 0A 7F 09 21 20 05 BD 09 0C 20 08 B6 80
0AB0 09 2A 0A 86 80 08 81 18 26 03 7E 09 56 39 FE 09
0AC0 12 08 BD 09 03 BD 09 03 BD 09 03 BD 09 06 08 FF
0AD0 09 15 CE 09 15 BD 09 06 FE 09 15 08 BD 09 06 39
0AE0 BF 09 12 30 6D 06 26 02 6A 05 6A 06 8D 09 30 EE
0AF0 05 FF 09 17 7E 09 AA B6 09 1E 84 3C 81 08 26 08
0B00 FE 09 19 B6 09 14 A7 00 FE 09 17 B6 09 18 A7 00
0B10 39 B6 09 1E 84 1C 26 03 8D 32 39 81 04 26 08 FE
0B20 09 19 FF 09 17 20 F1 81 08 26 04 8D 53 20 E9 81
0B30 0C 26 11 4F F6 09 19 30 EB 06 A9 05 B7 09 17 F7
0B40 09 18 20 04 30 EE 09 FF 09 17 20 CC FE 09 17 A6
0B50 00 B7 09 18 86 3F A7 00 A1 00 27 23 CE 09 17 BD
0B60 09 06 CE 08 92 BD 09 09 BD 0A 97 B6 09 1E 85 20
0B70 27 05 FE 09 1C 20 03 30 EE 08 FF 09 17 20 CD 39
0B80 FE 09 19 A6 00 B7 09 14 20 CA 0D 0A 00 00 00
0B90 3A 04 20 2A 2A 2A 20 20 20 52 4F 4D 0D 0A 00 00
0BA0 00 00 04 CE 09 22 C6 10 86 20 A7 00 08 5A 26 FA
0BB0 86 04 A7 00 FE 09 17 A6 00 B7 09 18 48 CE 0D F4
0BC0 FF 09 1C 24 03 7C 09 1C F6 09 1D 1B B7 09 1D 24
0BD0 03 7C 09 1C CE 09 22 B6 09 17 BD 0C FF B6 09 18
0BE0 BD 0C FF FE 09 1C A6 00 B7 09 1C E6 01 F7 09 1E
0BF0 C4 03 FE 09 17 A6 01 B7 09 19 A6 02 B7 09 1A 37
0C00 CE 09 27 B6 09 18 BD 0C FF 08 5A 27 0F B6 09 19
0C10 BD 0C FF 5A 27 06 B6 09 1A BD 0C FF 33 FE 09 17
0C20 08 5A 26 FC FF 09 17 B6 09 1C 16 CE 0D 19 FF 09
0C30 1C 48 24 04 7C 09 1C 0C 1B 24 03 7C 09 1C 0C 08
0C40 09 1D 24 03 7C 09 1C B7 09 1D FE 09 1C A6 00 B7
0C50 09 31 A6 01 B7 09 32 A6 02 B7 09 33 C6 20 F7 09
0C60 34 B6 09 1E 85 C0 27 08 2A 04 C6 41 20 02 C6 42
0C70 F7 09 35 CE 09 37 B6 09 31 81 2A 26 08 B6 09 1B
0C80 BD 0C FF 20 40 B6 09 1E 85 02 27 39 B6 09 1B 81

```

```

0C90 8D 27 12 84 F0 B7 09 1B 81 80 27 04 81 C0 26 05
0CA0 86 23 A7 00 08 B6 09 1B 81 8D 27 38 84 F0 81 20
0CB0 27 32 B6 09 19 BD 0C FF B6 09 1E 85 01 27 06 B6
0CC0 09 1A BD 0C FF B6 09 1B 81 60 27 08 81 A0 27 04
0CD0 81 E0 26 09 86 2C A7 00 08 86 58 A7 00 FE 09 17
0CE0 FF 09 1C 39 4F F6 09 19 2A 01 4A 0C FB 09 18 F7
0CF0 09 1A B9 09 17 B7 09 19 8D 05 17 8D 02 20 DE 36
0D00 8D 06 32 08 8D 06 08 39 44 44 44 44 84 0F 8B 30
0D10 81 39 23 02 8B 07 A7 00 39 2A 2A 2A 4E 4F 50 54
0D20 41 50 54 50 41 49 4E 58 44 45 58 43 4C 56 53 45
0D30 56 43 4C 43 53 45 43 43 4C 49 53 45 49 53 42 41
0D40 43 42 41 54 41 42 54 42 41 44 41 41 41 42 41 42
0D50 52 41 42 48 49 42 4C 53 42 43 43 42 43 53 42 4E
0D60 45 42 45 51 42 56 43 42 56 53 42 50 4C 42 40 49
0D70 42 47 45 42 4C 54 42 47 54 42 47 54 42 45 54 58 49
0D80 4E 53 50 55 4C 44 45 53 54 58 53 50 53 48 52 54
0D90 53 52 54 49 57 41 49 53 57 49 4E 45 47 43 4F 40
0DA0 4C 53 52 52 4F 52 41 53 52 41 53 4C 52 4F 4C 44
0DB0 45 43 49 4E 43 54 53 54 43 4C 52 4A 4D 50 53 55
0DC0 42 43 4D 50 53 42 43 41 4E 44 42 49 54 0C 44 41
0DD0 45 4F 52 41 44 43 4F 52 41 41 44 44 43 50 58 42
0DE0 53 52 4C 44 53 53 54 41 53 54 53 4A 53 52 4C 44
0DF0 58 53 54 58 00 01 01 01 01 01 01 00 01 00 01 00
0E00 02 01 03 01 04 01 05 01 06 01 07 01 08 01 09 01
0E10 0A 01 0B 01 0C 01 0D 01 0E 01 0F 01 00 01 00
0E20 0E 01 0F 01 00 01 10 01 00 01 11 01 00 01 00
0E30 00 01 00 01 12 06 00 01 13 0A 14 0A 15 0A 16 0A
0E40 17 0A 18 0A 19 0A 1A 0A 1C 0A 1D 0A 1E 0A
0E50 1F 0A 20 0A 21 01 22 01 23 81 23 41 24 01 25 01
0E60 26 81 26 41 00 01 27 11 00 01 28 11 00 01 00
0E70 29 01 2A 01 2B 81 00 01 00 01 2C 81 2D 81 00
0E80 2E 81 2F 81 30 81 31 81 32 81 00 01 33 81 34 81
0E90 00 01 35 81 2B 41 00 01 00 01 2C 41 2D 41 00
0EA0 2E 41 2F 41 30 41 31 41 32 41 00 01 33 41 34 41
0EB0 00 01 35 41 2B 02 00 01 00 01 2C 02 2D 02 00
0EC0 2E 02 2F 02 30 02 31 02 32 02 00 01 33 02 34 02
0ED0 36 0E 35 02 2B 03 00 01 00 01 2C 03 2D 03 00
0EE0 2E 03 2F 03 30 03 31 03 32 03 00 01 33 03 34 03
0EF0 36 07 35 03 37 82 38 82 39 82 00 01 3A 82 3B 82
0F00 3C 82 00 01 3D 82 3E 82 3F 82 40 82 41 03 42 26
0F10 43 03 00 01 37 82 3E 82 3F 82 40 82 41 02 3B 82
0F20 3C 82 44 82 3D 82 3E 82 3F 82 40 82 41 02 00 01
0F30 43 02 45 02 37 82 3E 82 3F 82 40 82 41 02 46 2E
0F40 3C 82 44 82 3D 82 3E 82 3F 82 40 82 41 02 46 2E
0F50 43 02 45 02 37 83 38 83 39 83 00 01 3A 83 3B 83
0F60 3C 83 44 83 3D 83 3E 83 3F 83 40 83 41 03 46 27
0F70 43 03 45 03 37 42 38 42 39 42 00 01 3A 42 3B 42
0F80 3C 42 00 01 3D 42 3E 42 3F 42 40 42 00 01 00 01
0F90 47 03 00 01 37 42 38 42 39 42 00 01 3A 42 3B 42
0FA0 3C 42 44 42 3D 42 3E 42 3F 42 40 42 00 01 00 01
0FB0 47 02 48 02 37 42 38 42 39 42 00 01 3A 42 3B 42
0FC0 3C 42 44 42 3D 42 3E 42 3F 42 40 42 00 01 00 01
0FD0 47 02 48 02 37 43 38 43 39 43 00 01 3A 43 3B 43
0FE0 3C 43 44 43 3D 43 3E 43 3F 43 40 43 00 01 00 01
0FF0 47 03 48 03 00 00 00 00 00 00 00 00 00 00 00
>

```

Hex listing of Trace and Disassemble program.

monitor.

Program B shows the disassembly of Tiny BASIC starting at address 0225 hex and finishing at 0280 hex. All values are in hexadecimal. Branch operands are the actual branch address. Direct addressing instructions are shown with two digit operands. If a location does not contain a valid op code, the disassembler will assume it is data and output asterisks (\*\*\*) for the mnemonic.

### Memory Examine and Change Function

This function can be used by the operator for inputting a program or making changes to an existing program. This function

can be performed by typing in the following response:

: M nnnn

The character M specifies a memory change function. The four hexadecimal digits following M specify the address to be examined or changed. Once the last digit is entered, the program will respond with the address and its contents:

: M 0103

0103 7E

The operator must now decide whether to change memory, space to the next location, back space to the previous location or return to the control monitor.

If the contents of memory are to be changed, just enter the

new value. The program will automatically output the next address and its contents. If the contents of memory cannot be changed, the program will output a (?) and return to the control monitor.

If the operator wishes to space to the next location, he'll just depress the space bar. The program will output the next location and its contents. For back spacing to the previous location, just depress the back space key (08 hex). The program will output the previous location and its contents. The back space function is useful for back spacing when an incorrect value is entered.

The memory change function

can be terminated by depressing the Escape key or entering an invalid hex character (see Example 6).

### Register Examine and Change Function

This function is used to ex-

```

: M 0103
0103 7E          (space)
0104 02          (back space)
0103 7E      BD
0104 02          (back space)
0103 BD      7E
0104 02          (space)
0105 25          (back space)
0104 02          (back space)
0103 7E          (escape)

```

Example 6.



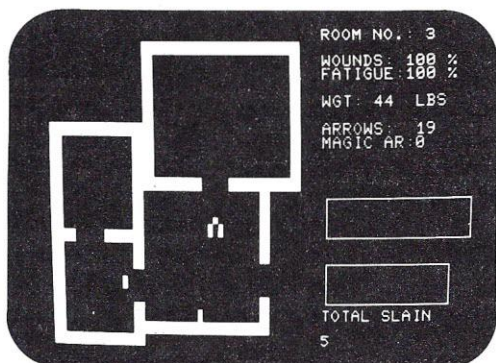
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|              |          |                              |
|--------------|----------|------------------------------|
| MPU Register | : R      |                              |
| cc           | A077 C1  | (space)                      |
| B            | A078 19  | FE                           |
| A            | A079 0D  | A0                           |
| XH           | A07A 22  | (space)                      |
| XL           | A07B 42  | (space)                      |
| PCH          | A07C 01  | (space)                      |
| PCL          | A07D 03  | (space)                      |
| RTNH         | A07E 02  | (space)                      |
| RTNL         | A07F 2A  | (space)                      |
|              | A080 FF  | (escape)                     |
|              | : T 0103 |                              |
|              | 0103 JMP | 0225 C1 FE A0 2242 A07D 022A |

Example 7.

amine and change the contents of the MPU registers prior to executing the trace or Go to User's Program function. The trace and Go to User's Program functions use the return from interrupt (RTI) instruction to return to the user's program. The RTI instruction updates all the MPU registers with the values stored away in the stack.

The register examine and

change function is initiated by entering the character R after the colon. The location of the first MPU register and its contents will be printed. The examining and changing of the data is done in the same manner as the M function (see Example 7).

#### Basic Memory Map

The 6800 Trace and Disassemble program resides in less

than 2K of memory. The hex listing accompanies the article. The program uses some of the MIKBUG I/O routines. Table 1 lists I/O routines used by the program.

There are some parameters that may have to be changed depending on your particular machine. The stack pointer, for example, is initially loaded to \$A042. If this value is changed, it should be set to at least ten locations down from the top of the stack.

The software interrupt vector is normally stored at location \$FFFA. In my home-brew system the software interrupt vector points to a ROM subroutine that uses location \$A014 as a programmable software interrupt vector. The Trace and Disassemble program initializes location \$A014 to the return address of the trace function. This address (\$A014) in the program will have to be changed to \$FFFA (if programmable) or to whatever the programmable location is in your particular machine.

The Back Space and Escape Codes can be modified. They are presently set to 08 hex and 1B hex, respectively.

#### Break Test Routine

The break test is used by the program during a trace or dis-

assemble program function. After each line of output the program jumps to the break test routine. The break test checks for a key being depressed. If one is not, the program returns normally. If a key is depressed, the character is input and tested for the Escape Code. If the character is not the Escape Code, the program exits from the routine normally. If the character is the Escape Code, the program returns to the control monitor.

Any changes to the break test must be made within the first three instructions. The remaining four are used by other routines within the program. There are some spare locations at the end of the program starting at \$0FF4 for modifications to the break test (see Example 8).

#### Summary

The 6800 Trace and Disassemble program is an effective debugging tool. It requires no hardware changes, as long as your system has a programmable SWI vector. I've used it many times and so have other 6800 users. It allows you to trace your program instruction by instruction. You can make changes to your program, disassemble your patches and then trace them. You can make a listing of your program and even the trace of your program.

If you would like to get a copy of the listing of the program for relocation purposes or whatever, just send \$5 with your name and address to:

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|                     |  |                              |
|---------------------|--|------------------------------|
|                     | JMP \$E1AC                             | OUTPUT 2 HEX CHARS AND SPACE |
| BASIC MEMORY MAP    |  |                              |
| 0900-0911           | I/O ROUTINES                           |                              |
| 0912-0949           | TEMPORARY STORAGE                      |                              |
| 094A                | START OF PROGRAM                       |                              |
| 094A-0D18           | EXECUTABLE PROGRAM                     |                              |
| 0B8A-0BA2           | PROMPT, INVALID CODE AND CRLF MESSAGES |                              |
| 0D19-0FF3           | MNEMONIC AND CODE TABLES               |                              |
| MIKBUG I/O ROUTINES |  |                              |
| 0900                | JMP \$E0CC                             | OUTPUT SPACE                 |
| 0903                | JMP \$E0CA                             | OUTPUT 2 HEX CHARS AND SPACE |
| 0906                | JMP \$E0C8                             | OUTPUT 4 HEX CHARS AND SPACE |
| 0909                | JMP \$E07E                             | OUTPUT MESSAGE               |
| 090C                | JMP \$E1AC                             | INPUT A CHAR                 |
| 090F                | JMP \$E1D1                             | OUTPUT A CHAR                |
| PARAMETERS          |  |                              |
| 094B-094C           | \$A042                                 | MIDDLE OF STACK              |
| 0954-0955           | \$A014                                 | SWI VECTOR (NORMALLY \$FFFA) |
| 0A37                | \$08                                   | BACKSPACE CODE               |
| 0AB7                | \$1B                                   | ESCAPE CODE                  |

Table 1. Memory map of I/O routines and parameters.

|              |   |
|--------------|---|
| T nnnn (CR)  | Trace instruction at location nnnn.   |
| T nnnn, mmmm | Trace program starting at location nnnn with breakpoint address set at mmmm.        |
| G nnnn (CR)  | Go to user's program starting at location nnnn.                                     |
| G nnnn, mmmm | Go to user's program starting at location nnnn with breakpoint address set at mmmm. |
| D nnnn (CR)  | Disassemble instruction at location nnnn.   |
| D nnnn, mmmm | Disassemble instruction at location nnnn and ending at location mmmm.               |
| M nnnn       | Examine memory location nnnn.   |
| R            | Examine MPU registers starting with condition code.                                 |
| (ESC)        | Escape from present function and return to control monitor.                         |

Table 2. Summary of control functions.

|      |       |      |         |                                |
|------|-------|------|---------|--------------------------------|
| 0AAE | BREAK | LDAA | \$8009  | PIA STATUS-KEY DEPRESSED?      |
| 0AB1 |       | BPL  | EXIT    | NO                             |
| 0AB3 |       | LDAA | \$8008  | YES, INPUT CHAR                |
| 0AB6 | CHECK | CMPA | #1B     | ESCAPE CODE?                   |
| 0AB8 |       | BNE  | EXIT    | NO                             |
| 0ABA |       | JMP  | CONTROL | YES, RETURN TO CONTROL MONITOR |
| 0ABD | EXIT  | RTS  |         | RETURN NORMAL                  |

Example 8.



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# Programming Optimization Techniques

---

*If you want to optimize a program, use the best approach—or don't bother.*

---

W. A. Harrison  
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**T**he most important step in coding an efficient program is to make sure that the procedure used is the best approach to the problem. Simply coding the best method, without any attempt to optimize the program, will generally result in a more efficient program than trying to optimize a second- or third-best approach.

Optimization of a computer program is usually done to accomplish one of two results: increased speed or decreased storage. In some cases, an optimizing technique can take on both aspects, and yet, others require a trade-off to be made in terms of speed and memory.

Our discussion in this article shall be limited to those techniques that increase the execution speed of a program.

Before we decide to attempt to optimize a program, we must first decide if our program is worth the effort required. Though you should always strive to code the most efficient program possible, some programs are not worth the effort it requires. An example of this is a short program that will only be used once or twice. On the other hand, a large program that involves a great deal of number-crunching, and is utilized quite often, may well be worth the effort required to optimize the code.

One of the most obvious methods of optimizing a computer program is by minimizing the number of operations the machine must perform. Yet this

is probably the single largest reason for program inefficiency. This is doubly important when an interpreter, such as BASIC, is used, which translates and then executes each source language statement as it is encountered, as opposed to a compiler (e.g., FORTRAN), which translates the entire source program first, and then executes the resulting machine code.

One of the largest areas of inefficiency in most programs is the placement of calculations within loops whose outcome is not affected by the operations taking place within the loop. In the program segment in Example 1, the expression  $C + R$  is executed 1000 times. The result, however, never varies. The program segment could be coded much more efficiently by placing the  $C + R$  calculation outside the loop and only calculat-

ing it once. This will result in the elimination of 999 unneeded evaluations of the expression  $C + R$ .

Likewise, any redundant expressions should be computed once, and the result stored in a temporary storage location to allow the machine to avoid repeating the calculation. In Example 2, the expression  $C + R$  is calculated several times. This segment could be more efficiently coded by setting the variable  $T$  equal to the results of  $C + R$  and using this value in the computations to avoid computing the expression over and over again.

Often, an expression whose value never changes from run to run will appear in a program. In Example 3, the value of  $X$  is always 3. Rather than requiring the machine to calculate this value every time the program is

| inefficient             | efficient               |
|-------------------------|-------------------------|
| 00100 FOR K = 1 TO 1000 | 00100 B = C + R         |
| 00110 B = C + R         | 00110 FOR K = 1 TO 1000 |
| 00120 Q1 = Q(K)/B       | 00120 Q1 = Q(K)/B       |
| 00100 NEXT K            | 00130 NEXT K            |

*Example 1.*

| inefficient         | efficient   |
|---------------------|-------------|
| 00100 X = LGT(1000) | 00100 X = 3 |

*Example 3.*

| inefficient                   | efficient           |
|-------------------------------|---------------------|
| 00100 R = (C + R)/A           | 00100 T = C + R     |
| 00110 S = (C + R)*A           | 00110 R = T/A       |
| 00120 U = C + R - ((C + R)*A) | 00120 S = T*A       |
|                               | 00130 U = T - (T*A) |

*Example 2.*

| inefficient         | efficient           |
|---------------------|---------------------|
| 00100 Q = (- C*100) | 00100 Q = (- 100*C) |

*Example 4.*



|                        |                               |
|------------------------|-------------------------------|
| inefficient            | efficient                     |
| 00100 FOR C = 1 TO 100 | 00100 FOR C = 2 TO 200 STEP 2 |
| 00110 A(C*2) = K       | 00110 A(C) = K                |
| 00120 NEXT C           | 00120 NEXT C                  |

Example 5.

|                        |                              |
|------------------------|------------------------------|
| inefficient            | efficient                    |
| 00100 FOR I = 1 TO 100 | I is set to 1 1 time         |
| 00110 FOR J = 1 TO 50  | J is set to 1 100 times      |
| 00120 FOR K = 1 TO 10  | K is set to 1 5000 times     |
|                        | result: 5101 initializations |

|                        |                             |
|------------------------|-----------------------------|
| efficient              | efficient                   |
| 00100 FOR K = 1 TO 10  | K is set to 1 1 time        |
| 00110 FOR J = 1 TO 50  | J is set to 1 10 times      |
| 00120 FOR I = 1 TO 100 | I is set to 1 500 times     |
|                        | result: 511 initializations |

Example 6.

executed, X can be set to 3, eliminating the computation.

A less obvious technique, yet one that can result in a small savings in time, is the proper positioning of a unary operator, such as the minus sign, preceding a variable. In Example 4, the operator "-" acting on the variable C requires the equivalent of  $C * (-1)$ . However, this segment could be programmed in a more efficient way that would eliminate the unary operation of  $(-1) *$  (the value -100 is a constant and does not require a unary operation to make it negative).

Efficiency can also be obtained by making full use of the FOR/NEXT increment parameters as shown in Example 5. This will eliminate the computation of  $C * 2$  at every iteration of the loop.

Often, small things can be overlooked by the programmer, yet they can make a significant savings when applied enough times. For example, every time a FOR/NEXT statement is executed, the loop counter must be initialized to the beginning value (in Example 6, each counter must be initialized to 1 at the beginning of the loop). By careful arrangement of the nested loops, the number of initializations may be reduced.

As we stated before, execution time is reduced when we can reduce the amount of work the machine must do. One very time-consuming operation in-

volves locating and retrieving a system library subroutine. In Example 7, the result is the same if a number is multiplied by itself (squared), or if the number it is being compared to has its square root computed. However, it takes less time to multiply two numbers together than to compute a square root.

In our quest for efficiency, we must also take into consideration how long it takes the machine to locate and retrieve the contents of a storage location referenced by a variable. In the case of a scalar (non-subscripted) variable, the system must consult a table, from which the address of that location is found. On the other hand, when a subscripted variable is referenced, the system must find the starting point of the array or vector, and then using the subscript, calculate the address of the storage location in question.

Because of this, when a subscripted variable is referenced several times, efficiency may be gained by setting a scalar variable equal to the subscripted variable and using the scalar variable for access. If this cannot be done, access time can still be increased by using a constant as a subscript rather than a variable (i.e.,  $V(7)$  instead of  $V(K)$ ). This is because when a variable is used as a subscript, the contents of the location referenced by the variable must be computed. In effect, two storage locations must be located and

|                               |                            |
|-------------------------------|----------------------------|
| inefficient                   | efficient                  |
| 00100 IF SQR(K) = N THEN 1000 | 00100 IF K = N*N THEN 1000 |

Example 7.

|                    |                    |                 |
|--------------------|--------------------|-----------------|
| inefficient        | more efficient     | most efficient  |
| 00100 M = C(K) + 8 | 00100 M = C(3) + 8 | 00100 T = C(3)  |
| 00110 N = C(K) * 8 | 00110 N = C(3) * 8 | 00110 M = T + 8 |
| 00150 Z = C(K) / 2 | 00150 Z = C(3) / 2 | 00150 Z = T / 2 |

Example 8.

|                               |                               |
|-------------------------------|-------------------------------|
| inefficient                   | efficient                     |
| 00100 FOR K = 1 TO N          | 00100 A(N + 1) = V            |
| 00110 IF A(K) = V THEN 150    | 00110 K = 0                   |
| 00120 NEXT K                  | 00120 K = K + 1               |
| 00130 PRINT "VALUE NOT FOUND" | 00130 IF A(K) = V THEN 150    |
| 00140 STOP                    | 00140 GOTO 120                |
|                               | 00150 IF K <= N THEN 180      |
|                               | 00160 PRINT "VALUE NOT FOUND" |
|                               | 00170 STOP                    |

Example 9.

retrieved. See Example 8.

Probably the most time-consuming operation carried out by a computer is the decision operation. Because of this, the use of IF statements should be minimized whenever possible. Through commonsense programming, you can often eliminate, if not the use of, at least the execution of, a number of IF statements (e.g., positioning the most likely test first in order to branch around a number of other IF statements when testing a value for a number of conditions).

The programmer must also keep in mind that the IF statement is not the only operation that requires a decision-making operation. There are several operations that require implicit condition testing. An example is the FOR/NEXT statement. The

counter is checked every time a loop is executed to determine if the iteration should continue, or if the loop should be terminated. Because of this, the FOR/NEXT statement is not always the most desirable method of performing a loop.

In Example 9, up to  $2N$  decisions must be made to determine if the value being sought, V, is in the array A. A more efficient method would be to eliminate the FOR/NEXT operation as shown in the example. This would require only up to  $N + 2$  decision operations.

Of course, the amount of time saved by utilizing the preceding techniques may be slight, but if they are used consistently, especially in those huge number-crunchers referred to earlier, the savings in computer time can be considerable. ■

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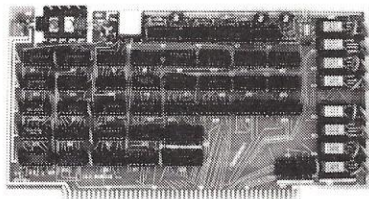
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# Software for the AIM 65

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*Unravel some mysteries of the AIM 65's monitor subroutines.*

---

John D. Williams  
8832 Boehning Ct.  
Indianapolis IN 46219

**W**ith the wide variety of single-board computers on the market today, you might think that the introduction of yet another is hardly needed. But the AIM 65 by Rockwell fills a gap left by other single-board computers. Its many features provide capabilities beyond those of the usual single-board systems, yet it costs little more.

The AIM 65 is a versatile microcomputer. It is a 6502-based system with ASCII keyboard, 20 column thermal printer and 20 character alphanumeric display. The basic unit includes an 8K monitor/miniassembler, two parallel I/O ports and 1K of 2114 RAM. An additional 3K RAM, assembler and 8K Microsoft BASIC are available as on-board options.

Though little has been written about this system, it should be given serious consideration by anyone wishing to purchase a single-board computer. The purpose of this article is to briefly discuss the hardware aspects of the AIM 65 and then unravel a few of the mysteries surrounding the use of the monitor subroutines in programming. I hope it will also provide some insights into the use of the two parallel ports for control or interface

applications.

## Introduction

The AIM 65 has two buses: one is an expansion bus for adding additional memory; the other is an application bus. Part of this bus consists of two 8-bit parallel I/O ports with four control lines. These ports are controlled by a 6522 VIA.

The VIA (versatile interface adapter) also has an 8-bit shift register to convert data between parallel and serial formats, interrupt logic that can be polled and two 16-bit timers that can produce a single pulse or a series of pulses. One of the timers will be used as the basis of the real-time clock in the program. The parallel ports will provide the interface to the outside world.

The program was written to read voltage from a Valhalla True RMS Wattmeter. It will record the changes in voltage

and the time of those changes. But its real usefulness lies in demonstrating how you can use several unique features of the AIM in ways not mentioned in the *User's Manual*.

Specifically, the program uses the monitor's text editor to store the original prompt and subsequent statements used in the printout. It also uses both parallel I/O ports to specify what information is wanted and then to collect it. Finally, a real-time clock is used with one of the VIA's timers as its basis.

## Monitor Subroutines

Listing 1 shows the text that is used. The text editor is used to store this section of the program. This feature is more convenient than stuffing consecutive memory locations with the proper ASCII codes. Simply begin the text buffer at address \$0700. Be sure to hit return twice after all of the text is entered. This inserts \$00 at the end of the text to signal the end of the text. It also stores the end text address in locations \$00E1-00E2.

You may also want to employ one of the user-function keys to run the program. Program JMP 0400 at location \$010C and JMP 0200 at location \$010F. The program will begin running when you hit the F1 key. The F2 key starts the clock running and begins the voltage-monitoring section of the program. If the program is to be stored on tape, be sure to store addresses \$010C-\$0112 on the tape also. This allows the program to use F1 and F2 after being loaded

from cassette tape.

The program in Listing 2 can be broken into four parts. Addresses \$0200-0274 initialize the real-time clock and provide a printer and display for the clock. Locations \$0300-033C contain the interrupt routine for the clock. The clock routine is similar to the one by Marvin L. DeJong in the March 1979 issue of *Micro*. The major change is in the clock display routine.

Locations \$0400-04AD output the original prompt to the display and printer. They also allow you to input the time at which the main program will be started. Locations \$0500-0593 monitor the voltage and output the change and time when the change occurred.

In the first section (\$0200-0274), the first 18 instructions initialize the values for the 6522 VIA timer 1 interrupts. Locations \$0215-021C store \$C342 as the clock interrupt frequency. Locations \$0226-0274 contain the display routine, which outputs the time to the display and printer. At location \$0232 the X register is loaded with the value \$0D. This is done because the value of the X register determines a character's position on the display. The actual display of the character is accomplished at location \$024E by JSR E97A.

Location \$E97A, an address in the AIM 65 monitor, is the start of a subroutine that takes an ASCII character in the accumulator and outputs it to the display and printer. The only problem is that the time is

```
<G>/
THE VOLTAGE IS
VRMS-60HZ.
THE TIME IS
THIS PROGRAM WILL
MONITOR LINE VOLTAGE
AND RECORD THE
CHANGES. IT WILL
ALSO RECORD THE TIME
OF THE CHANGES.
TO INITIALIZE THE
PROGRAM, ENTER THE
TIME IN THIS FASHION
HR:MIN:SEC.
ALLOW TWO DIGITS PER
UNIT. THEN HIT F2 TO
START THE PROGRAM AT
THE RIGHT TIME.
```

*Listing 1. Program text.*



# Listing 2.

```

0200 78 SEI
0201 A9 LDA #00
0203 8D STA A404
0206 A9 LDA #03
0208 8D STA A405
020B A9 LDA #C0
020D 8D STA A00E
0210 A9 LDA #40
0212 8D STA A00B
0215 A9 LDA #42
0217 8D STA A006
021A A9 LDA #C3
021C 8D STA A005
021F A9 LDA #EC
0221 85 STA 00
0223 58 CLI
0224 00 BRK
0225 EA NOP
0226 A5 LDA 01
0228 85 STA 04
022A A5 LDA 02
022C 85 STA 05
022E A5 LDA 03
0230 85 STA 06
0232 A2 LDX #0D
0234 A0 LDY #06
0236 B9 LDA 0000, Y
0239 85 STA 10
023B 98 TYA
023C 85 STA 11
023E A0 LDY #04
0240 66 ROR 10
0242 88 DEY
0243 C0 CPY #00
0245 D0 BNE 0240
0247 A5 LDA 10
0249 29 AND #0F
024B 18 CLC
024C 69 ADC #30
024E 20 JSR E97A
0251 E8 INX
0252 A5 LDA 11
0254 88 TAY
0255 B9 LDA 0000, Y
0258 29 AND #0F
025A 18 CLC
025B 69 ADC #30
025D 20 JSR E97A
0260 E8 INX
0261 88 DEY
0262 C0 CPY #03
0264 F0 BEQ 026E
0266 A9 LDA #3A

```

stored in decimal form in the memory.

Before the characters can be displayed, they must be converted to the ASCII format. This is accomplished by first storing the two-digit number in an address where it can be manipulated. The number is rotated right four bits so that the most significant nibble (MSN) is now the least significant nibble (LSN). It is then ANDed with \$0F to save only the LSN. \$30 is then added to produce the correct ASCII code for any decimal number 0-9.

To display the second number of the pair, the original two

```

0268 20 JSR E97A
026B 4C JMP 0236
026E 20 JSR EA13
0271 20 JSR EA13
0274 4C JMP 0500
0277 EA NOP
0300 48 PHA
0301 E6 INC 00
0303 D0 BNE 0337
0305 F8 SED
0306 18 CLC
0307 A5 LDA 01
0309 69 ADC #01
030B 85 STA 01
030D C9 CMP #60
030F 90 BCC 0333
0311 A9 LDA #00
0313 85 STA 01
0315 18 CLC
0316 A5 LDA 02
0318 69 ADC #01
031A 85 STA 02
031C C9 CMP #60
031E 90 BCC 0333
0320 A9 LDA #00
0322 85 STA 02
0324 18 CLC
0325 A5 LDA 03
0327 69 ADC #01
0329 85 STA 03
032B C9 CMP #24
032D 90 BCC 0333
032F A9 LDA #00
0331 85 STA 03
0333 A9 LDA #EC
0335 85 STA 00
0337 AD LDA A004
033A D8 CLD
033B 68 PLA
033C 40 RTI
033D EA NOP
0400 A2 LDX #00
0402 A0 LDY #00
0404 A9 LDA #00
0406 8D STA 04F0
0409 B9 LDA 072E, Y
040C C9 CMP #0D
040E F0 BEQ 0418
0410 20 JSR E97A
0413 E8 INX
0414 C8 INY
0415 4C JMP 0409
0418 20 JSR EA13
041B A2 LDX #00
041D C8 INY
041E EE INC 04F0
0421 AD LDA 04F0
0424 C9 CMP #07
0426 D0 BNE 0409
0428 A0 LDY #00
042A B9 LDA 07AE, Y
042D C9 CMP #0D
042F F0 BEQ 0439
0431 20 JSR E97A
0434 E8 INX

```

digits are once again retrieved from memory. It is not necessary to rotate this data since the LSN is in the proper place. It is simply converted to ASCII in the same manner as the other and displayed. Between the hours, minutes and seconds, a colon is displayed.

After the time has been displayed, there is another jump to a monitor subroutine. The sub-

routine at \$EA13 outputs a carriage return and line feed to the display and printer. This is done twice. The final instruction executes a jump to another section of the program, which looks for a change in voltage.

The second section, from locations \$0300-\$033C, is the clock. This section is used every time an interrupt is generated by

```

0435 C8 INY
0436 4C JMP 042A
0439 20 JSR EA13
043C C8 INY
043D A2 LDX #00
043F EE INC 04F0
0442 AD LDA 04F0
0445 C9 CMP #0E
0447 D0 BNE 042A
0449 20 JSR E95F
044C 8D STA 04F1
044F 20 JSR E95F
0452 8D STA 04F2
0455 20 JSR E95F
0458 8D STA 04F3
045B 20 JSR E95F
045E 8D STA 04F4
0461 20 JSR E95F
0464 8D STA 04F5
0467 20 JSR E95F
046A 8D STA 04F6
046D A2 LDX #01
046F A0 LDY #04
0471 3E ROL 04F0, X
0474 88 DEY
0475 C0 CPY #00
0477 D0 BNE 0471
0479 BD LDA 04F0, X
047C 29 AND #F0
047E 18 CLC
047F 9D STA 04F0, X
0482 E8 INX
0483 E8 INX
0484 E0 CPX #07
0486 D0 BNE 046F
0488 A2 LDX #02
048A BD LDA 04F0, X
048D 29 AND #0F
048F 18 CLC
0490 CA DEX
0491 7D ADC 04F0, X
0494 9D STA 04F0, X
0497 E8 INX
0498 E8 INX
0499 E8 INX
049A E0 CPX #08
049C D0 BNE 048A
049E AD LDA 04F1
04A1 85 STA 03
04A3 AD LDA 04F3
04A6 85 STA 02
04A8 AD LDA 04F5
04AB 85 STA 01
04AD 60 RTS
0500 A9 LDA #FF
0502 8D STA A002
0505 A9 LDA #00
0507 8D STA A003
050A A2 LDX #00
050C A0 LDY #00
050E A9 LDA #02
0510 8D STA 0625
0513 8D STA A000
0516 AD LDA A00F
0519 9D STA 0600, X

```

the timer in the VIA. When 24 hours are up, the clock resets itself and continues to run. The clock continues to keep fairly accurate time even while other parts of the program are being run.

The third section, locations \$0400-\$04AD, outputs the original prompt and allows the user to input the time he wishes to start the program. The use of the text buffer as the source of the prompt is accomplished by using the X register as the display counter, the Y register as the text buffer location counter and \$04F0 as a text line counter. The characters are loaded into the accumulator by using absolute indexed addressing.

```

051C DD CMP 0650, X
051F D0 BNE 0542
0521 BD LDA 0600, X
0524 9D STA 0650, X
0527 E8 INX
0528 CE DEC 0625
052B AD LDA 0625
052E C9 CMP #00
0530 D0 BNE 0513
0532 8D STA A000
0535 AD LDA A00F
0538 9D STA 0600, X
053B DD CMP 0650, X
053E D0 BNE 0546
0540 F0 BEQ 054D
0542 C8 INY
0543 4C JMP 0521
0546 C8 INY
0547 BD LDA 0600, X
054A 9D STA 0650, X
054D 98 TYA
054E C0 CPY #00
0550 F0 BEQ 050A
0552 A2 LDX #00
0554 BD LDA 0700, X
0557 C9 CMP #0D
0559 F0 BEQ 0562
055B 20 JSR E97A
055E E8 INX
055F 4C JMP 0554
0562 20 JSR EA13
0565 A2 LDX #00
0567 BD LDA 0650, X
056A 20 JSR E97A
056D E8 INX
056E E0 CPX #03
0570 D0 BNE 0567
0572 BD LDA 0713, X
0575 C9 CMP #0D
0577 F0 BEQ 0580
0579 20 JSR E97A
057C E8 INX
057D 4C JMP 0572
0580 20 JSR EA13
0583 A2 LDX #00
0585 BD LDA 0721, X
0588 C9 CMP #0D
058A F0 BEQ 0593
058C 20 JSR E97A
058F E8 INX
0590 4C JMP 0585
0593 4C JMP 0226
0596 EA NOP

```



The absolute address is the starting address of the text. The Y register is then added to the absolute address to obtain the correct address for the character to be displayed. The Y register is then incremented to obtain the consecutive characters. A carriage return (ASCII \$0D) will be found at the end of each line.

When a CR is loaded into the accumulator, the program jumps to a subroutine that outputs a carriage return and line feed to the display and printer. The Y register is incremented to be ready to fetch the next character. The X register is set to zero in order that the next line of characters appears at the proper place on the display and printer. Address \$04F0 is then incremented and tested to see if all the lines of the text have been output. If not, the program branches back to \$042A, ready to fetch the next line. Otherwise, the program looks at the keyboard using another subroutine.

At this point, the user inputs the time he will start the program. The clock will use this time as its starting time. The hour, minute and second times are input as two-digit numbers (eg., 01:15:30). Since each number is in ASCII format as it is taken from the keyboard, the two numbers for each division must be converted to decimal form and combined into one byte. This is done at locations \$046D-\$049C.

The decimal numbers are then loaded into the proper addresses for use by the clock. The program then returns to the monitor. When the time input to the clock is reached, the user hits F2 and the program begins to run.

The final section (\$0500-\$0599) reads data from the meter and outputs the changes to the display and printer. This is accomplished by using ports A and B of the 6522 VIA. As it is presently structured, the program will read three digits by outputting on port B which digit it wishes to look at. It then reads the data on port A. Both the digits read and those output are in BCD format.

The first four instructions ini-

```
<<>THIS PROGRAM WILL
MONITOR LINE VOLTAGE
AND RECORD THE
CHANGES. IT WILL
ALSO RECORD THE TIME
OF THE CHANGES.
```

```
TO INITIALIZE THE
PROGRAM, ENTER THE
TIME IN THIS FASHION
HR:MIN:SEC.
```

```
ALLOW TWO DIGITS PER
UNIT. THEN HIT F2 TO
START THE PROGRAM AT
THE RIGHT TIME.
```

```
112220
<>11:22:20
```

```
THE VOLTAGE IS
042VRMS-60HZ.
THE TIME IS 11:22:22
```

```
THE VOLTAGE IS
046VRMS-60HZ.
THE TIME IS 11:22:31
```

```
THE VOLTAGE IS
074VRMS-60HZ.
THE TIME IS 11:22:33
```

```
THE VOLTAGE IS
120VRMS-60HZ.
THE TIME IS 11:22:36
```

```
THE VOLTAGE IS
114VRMS-60HZ.
THE TIME IS 11:22:38
```

```
THE VOLTAGE IS
117VRMS-60HZ.
THE TIME IS 11:22:40
```

```
THE VOLTAGE IS
116VRMS-60HZ.
THE TIME IS 11:22:42
```

```
THE VOLTAGE IS
117VRMS-60HZ.
THE TIME IS 11:22:44
```

*Listing 3. Sample run.*

tialize port B as an output port and port A as an input port. While this program initializes the entire port as one or the other, each individual bit can actually be selected as an input or output. The requested digit is output on port B by loading address \$A000 with the requested digit.

The most significant digit is chosen first. It is then compared with the previous reading. If it is not the same, the reading is stored and the Y register is incremented.

After the three digits have been read, the Y register is checked to see if any digits have changed. If not, the process is started again. If the data has changed, more text is taken from the text buffer. It explains

what the data is. The new voltage is then output to the display and printer. The clock is then checked, and the current time is also output. The process then begins again.

The simplicity of using the I/O ports should now be evident. All you have to do is to select the function of the port by loading the proper address with 1s or 0s. Even the individual bits can be independently programmed for function. The port can then be read by loading the accumulator with the value found at the port's address. Data can be output on a port by storing the data at the port's address. What could be simpler than that?

This program looks at a different digit approximately 8000 times per second. This means a complete reading is done 44 times per line cycle. The only drawback is that most digital voltmeters do not update their output nearly that fast. Your ability to use this program to record voltage fluctuations or line spikes will be limited by the meter used for the measure-

ments.

Listing 3 is a sample run of the program. Note that when inputting the time, you do not separate the hours, minutes and seconds by colons. These are inserted by the program for the output. Although this program was run on an AIM 65 with 4K RAM, it is easily run in the 1K version. The only change involved is the reassigning of addresses.

#### Alternative Method

This program uses absolute indexed addressing to output text from the text buffer. The advantage of this method is that it takes few steps to accomplish. The drawback is that it can only make use of text no longer than 256 characters.

Listing 4 shows an alternative method of outputting text. It uses indirect indexed addressing. While it takes more steps to accomplish the same goal, it can address text of up to 64K characters in length.

This particular example starts the text address at \$0200. This information is stored at locations \$A0 and \$A1. Address \$A2 is used as the text line counter.

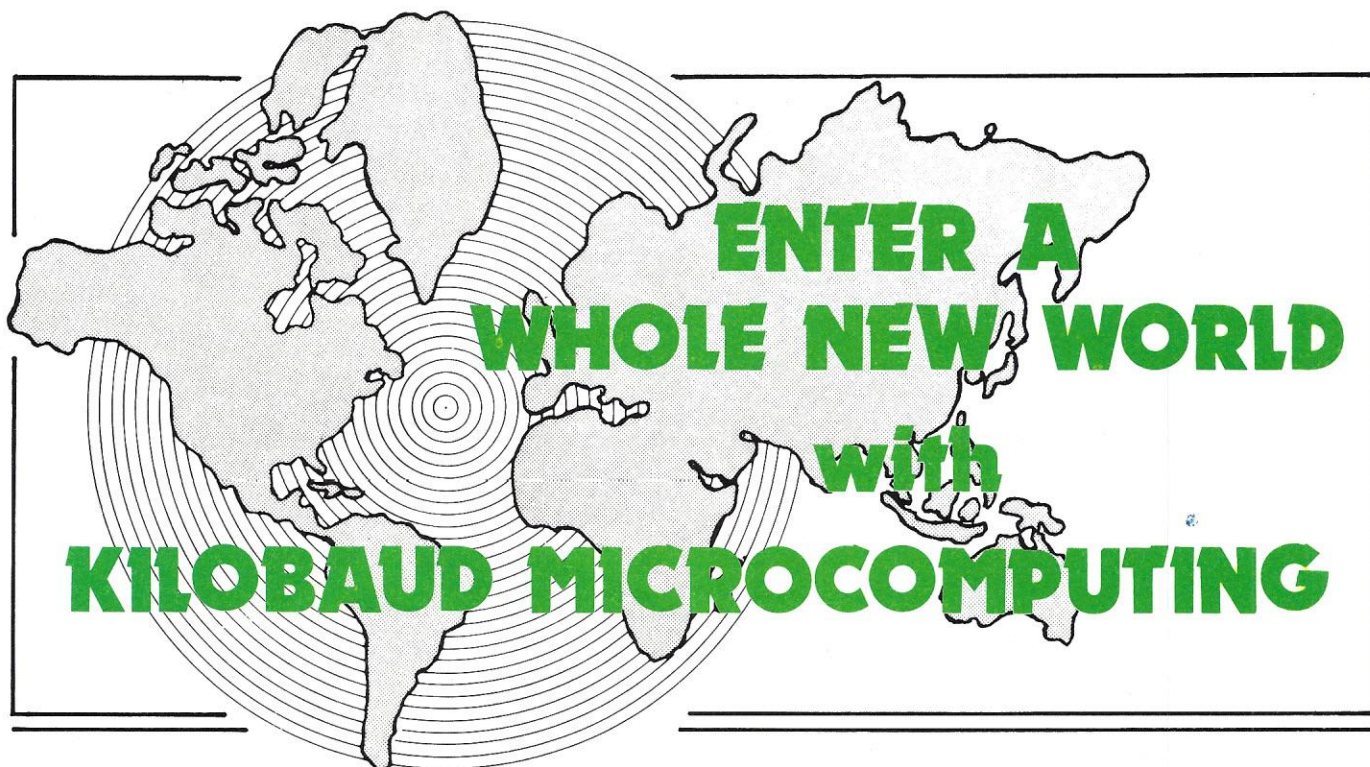
Once again it is the carriage return (ASCII \$0D) that is used to detect the end of a line. The Y register is incremented to \$FF and then added to the address found at \$00A0 and \$00A1. \$00A0 contains the low-order byte of the text address, while \$00A1 contains the high-order byte. Since the address at \$A0 and \$A1 can be changed, any length text at any location can be addressed. This method has been used successfully to print text over 1K in length.

This program uses many of the unique features of the AIM 65. The text editor, parallel I/O ports and the wide variety of monitor subroutines provide a combination of features not to be found anywhere else in the world of single-board computers. The AIM is easy to use once the user has unlocked a few of its secrets and is able to make use of the monitor subroutines and other features. I hope that this program has given you some new insights into programming the AIM 65. ■

```
0000 A9 LDA #00
0002 85 STA A0
0004 85 STA A2
0006 A9 LDA #02
0008 85 STA A1
000A A0 LDY #00
000C B1 LDA (A0),Y
000E C9 CMP #0D
0010 F0 BEQ 002F
0012 20 JSR E97A
0015 C0 CPY #FF
0017 F0 BEQ 001D
0019 C8 INY
001A 4C JMP 000C
001D 18 CLC
001E A5 LDA A0
0020 69 ADC #FF
0022 85 STA A0
0024 A5 LDA A1
0026 69 ADC #00
0028 85 STA A1
002A C8 INY
002B C8 INY
002C 4C JMP 000C
002F 20 JSR E913
0032 E6 INC A2
0034 A5 LDA A2
0036 C9 CMP #10
0038 F0 BEQ 0042
003A C0 CPY #FF
003C F0 BEQ 001D
003E C8 INY
003F 4C JMP 000C
0042 EA NOP
0043 60 RTS
0044 EA NOP
```

*Listing 4. Alternative method of text display.*





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Exp. date \_\_\_\_\_ Interbank # \_\_\_\_\_

Signature \_\_\_\_\_

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

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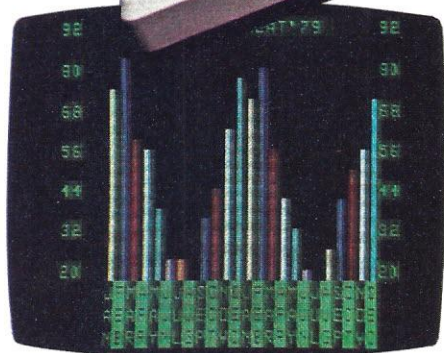
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# Physician: Automate Thyself

---

*Doctors who have computerized their accounts are saving both time and money.*

---

Robert Charles Bauman  
509 Wolcott Rd.  
Wolcott CT 06716

**W**hy would an optometrist in practice less than 12 months need a computer system in his office? If your background in computers is limited, you might imagine that a computer system — even a very small one — would only be necessary to process thousands of bills or perhaps prepare payroll checks for hundreds of employees. After the year we have been in practice, our office does not process thousands of patient bills, nor do we have hundreds of employees. But our computer is busy every day.

## Eye-opening Applications

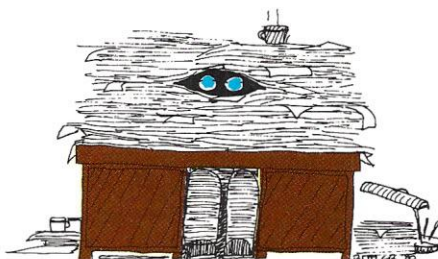
Our microcomputer is a versatile communication tool. It is an enthusiastic spokesman for my office and optometry in general. It tells my patients that this office is unique, that we really care about our patients as individuals.

A microcomputer is a useful addition to your office when it becomes too time consuming or expensive for your staff to send a personalized thank-you letter to all patients seen in your office. The computer can also send a personal recall letter to each patient due for recheck. The few monthly bills that our office sends out to patients are easily handled by office staff. But in most offices, the staff cannot send a personal thank-you letter to all patients seen, or a personalized recall letter to all patients.

With recent advances in the electronics field, a computer system that cost \$50,000–\$60,000 ten years ago now costs less than \$10,000. This revolution in electronics can put the power of the computer within reach of most practitioners. Studies

estimate that 80 percent of all microcomputers purchased will be used to perform word-processing tasks. Manipulation of the written word can allow you to compose and edit letters, manuscripts and reports, for example. This article was composed, corrected and edited on my system. With such systems, a poor typist such as myself can still generate good-looking text at speeds that approach or exceed those of a typist with expert skills.

Telling our patients what we do is as important as the services we actually perform. Large corporations have made effective use of mass communication. Now optometrists have the same capability.



**A microcomputer is useful in your office when it becomes too expensive to send personalized letters to all patients.**

In all but the largest optometric offices, a computer does not have to store patient records; the file cabinet can handle that. In most offices, the computer will not keep frame inventories, nor will it play chess. Although a computer is capable of performing these tasks, our computer is put to other uses.

In our office the computer will generate a thank-you letter to each patient. In this letter a recall date of so many months is mentioned. This establishes in the patient's mind the need for regular eye care.

The date of the last visit, as well as any other informative information, is mentioned. With high postage costs today it is not cost-effective to use a postcard for patient recall notices. This type of notification system tells your patients that this doctor is the same as all the others. In his office, patients are just numbers.

For a few cents more, a computer can generate a personal note that shouts, "My doctor really cares!" Such letters not only can improve recall performance but can actually result in more referrals. Today, computer technology can generate a letter and address the envelope in less than 40 seconds. Such letters are indistinguishable from letters typed by hand, except the computer never presses the wrong keys.

With a little more imagination, this communication device can be used to even greater advantage. Do you think your contact lens patients or prospective contact lens patients would respond to a personal letter informing them of a new development in the contact lens field? Those practitioners involved in visual training generate scores of reports. Why not let the computer communicate for you? Teachers, school nurses and parents will all respond in a positive manner to a personal report from your office.

As professionals, we have only a limited supply of time to share with our patients. Automation, if properly used, can free the doctor and staff from busywork so more time can be spent on tasks that take judgment and insight.

## Purchasing a Computer System

Equipment purchased must justify its cost by enhancing the practice and removing an element of drudgery for doctor or staff. A microcomputer excels in both areas. Computers, unlike people, are at their best when performing repetitious



tasks. Any activity that is performed on a regular basis can be better handled by the computer.

To make the purchase and integration of a computer system in your office as painless as possible, do some homework. Learn what you can reasonably expect a computer system to do. Most areas of the country are within a few hours' drive of a retail computer store that specializes in systems for the professional practice or the small businessman.

These stores generally have abundant reference materials on hand. Computer journals that are entirely devoted to the small computer system are available. These magazines provide an excellent education; you may find the advertisements useful. Easy-to-understand books on the subject of microcomputers are informative. Computer clubs are generally willing to help the beginner avoid costly errors.

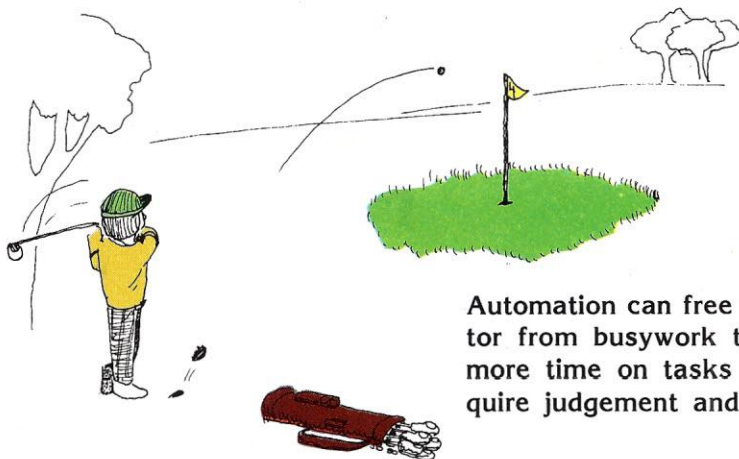
A few general principles will make the purchase easier. A small computer system does not cost \$1000. Although hobby computers are available in that price range, a useful system will range in cost from \$4000-\$10,000 for hardware. Although the cost of computers may fluctuate slightly in the future, significant price reductions are unlikely. Those waiting for a \$10,000 computer system to decrease in cost to \$4.95 will still be waiting five years from now.

Above all, I have learned that all computer equipment will need service eventually. If cost is a major concern, much of the necessary equipment can be purchased in kit form, with significant savings. A detailed knowledge of electronics is not necessary. I built my system in kit form at a total cost of \$4500. Although I had built electronic kits before, my experience in electronics was minimal. If time is an overriding factor, then purchase assembled equipment.

### What You Need

All computer systems have some components in common. Our system's basic computer is a small box about the size of a stereo receiver. The cabinet holds the memory circuits and controls all other components of the system. Simple systems have fewer memory circuits; powerful systems have more. Many computers, such as mine, have made provision for adding additional memory circuit boards as the need arises. My system has the ability to store 32,000 (32K) pieces of information, or bytes. A capacity of 24,000 (24K) bytes is about minimal.

In addition to the computer, we must have equipment to communicate our desires to the computer. Most often this is accomplished by a keyboard terminal at-



**Automation can free the doctor from busywork to spend more time on tasks that require judgement and insight.**

tached to a modified television screen.

The television-type terminal allows me to compose a report, for example, and make any changes or corrections on the screen. Once satisfied, I can instruct the computer to type the final version with 100 percent accuracy. This greatly speeds up the process of writing letters and manuscripts. In addition, the letter can be filed in the computer's memory and recalled when desired.

Although the computer can communicate with me by using the television-type terminal, a useful system will have a device that the computer can control to generate written copy, or hard copy. Although many printers are available, the daisy-wheel type is best. This kind of printer is fast—about 55 characters per second can be printed. The output from this type of printer cannot be distinguished from print generated on the best electronic typewriter. Many computer printers can also function as a standard typewriter when not connected to the computer.

In addition to the memory circuits contained in the computer itself, provision has to be made for permanent external storage of information. This is necessary because most computers "forget" what is in their memory when the power is turned off. External storage devices retain memory even after the power is turned off.

Most often magnetic disks are used to store this information. These disks resemble 45 rpm records. All programs and data files are stored on such disks, which are then placed in a disk drive unit to be read by the computer. This type of device also allows for easy duplication of data disks that store valuable information, so a duplicate disk can be made.

### Software Requirements

Up to this point I have mentioned the equipment or hardware necessary for a complete computer system. In order for

any computer system to perform useful work, it must be told exactly what to do. Hardware is not useful until software programs that tell the computer to do exactly what is desired are acquired.

Most programs written for microcomputers use a simple computer language called BASIC. Many first-time computer users have taught themselves this programming language. Self-study manuals are available on the subject. Even though simple programs can be written by the novice, more elaborate computer programs such as those controlling computer billings require professional programming assistance.

Software availability is important. More than one doctor has purchased a computer system only to find that no software exists to perform the tasks he wants done. Custom software is available, but quality software is expensive. Since software from one system may not run on another system, computer equipment must be purchased from reliable sources. Believe only what you have actually seen demonstrated before you make any equipment purchases.

Good software allows even the inexperienced to operate a computer properly. It leads the operator "by the nose" so errors are minimal. Although I have written all software myself, busy practitioners will want to rely on purchased software.

### Conclusion

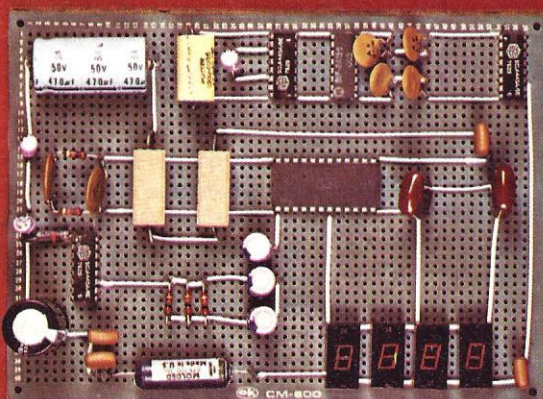
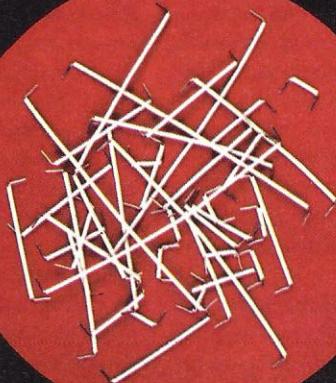
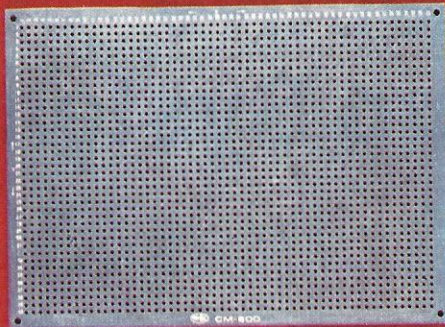
Although a computer system is more difficult to purchase than many other types of office equipment, the doctor who takes the time to educate himself on the subject or can obtain help from an individual familiar with microcomputer systems will find the experience painless.

If properly used, the office computer can convert satisfied patients into enthusiastic patients. It can free the doctor and staff from many chores. Put this tool to work in your office. ■





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# A Cost-Effective Multi-user Micro System

*When a 16-station system was needed, this clinic developed its own—and saved a bundle.*

Wayne M. Kashinsky  
Dr. Raymond G. Romanczyk  
Dept. of Psychology  
State University of New York  
at Binghamton  
Binghamton NY 13901

In educational or clinical settings, it is often desirable to have quick access to a file containing information about the progress or treatment of an individual. There are also other settings that require many people to have simultaneous access to pre-stored data. In the past, these applications required large, time-sharing computer systems, which were often prohibitively expensive and complex. Furthermore, the addition of each user terminal is a significant expense (approximately \$1000).

To meet this multi-user need—especially in a clinical/educational setting—we developed a low-cost, flexible, 16-station system. The cost of the complete computer system, including a printer, is less than \$5000, with each user station costing approximately \$100.

Thus, if you can keep the amount of data needed on-line for immediate access on two to four floppy diskettes (under 2 megabytes), you can make use of our implementation of a multi-user microprocessor system.

## Specific Application in a Clinical Setting

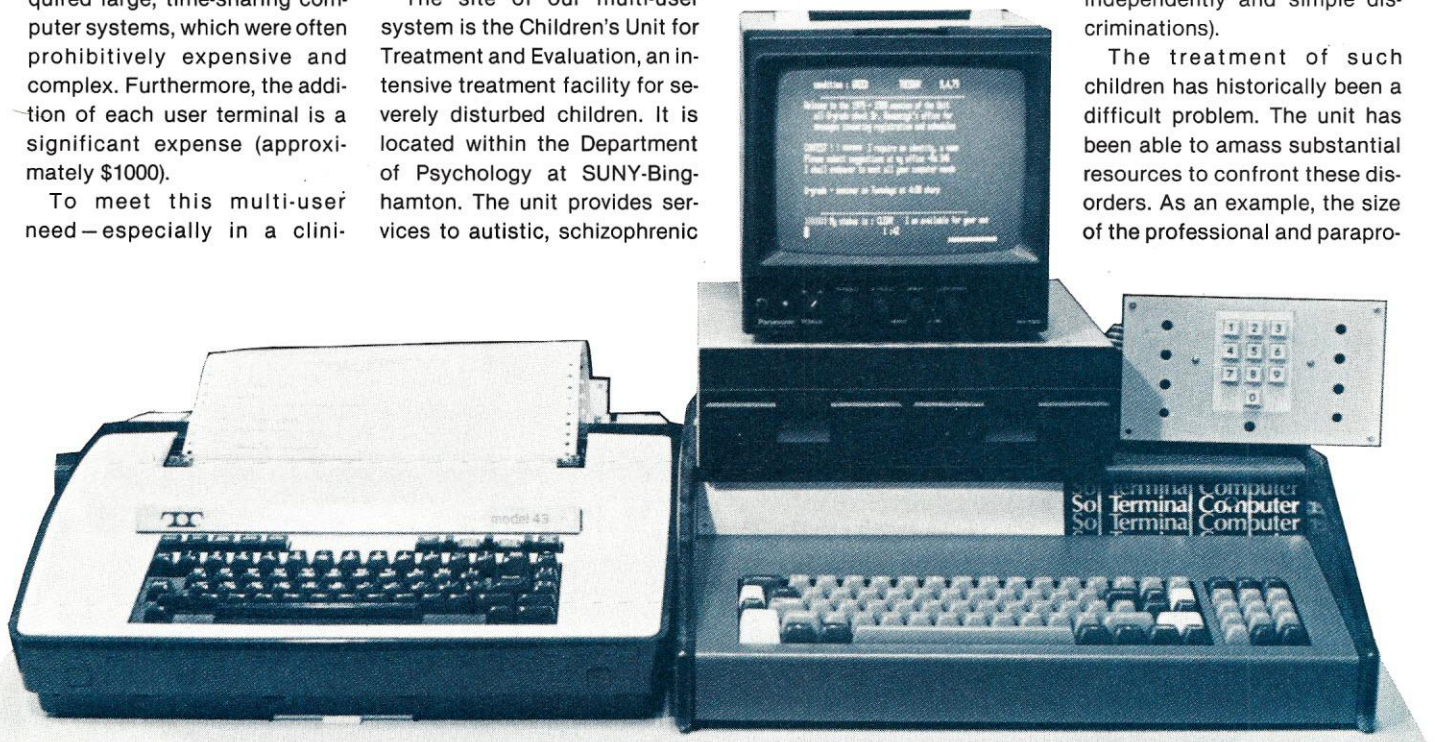
The site of our multi-user system is the Children's Unit for Treatment and Evaluation, an intensive treatment facility for severely disturbed children. It is located within the Department of Psychology at SUNY-Binghamton. The unit provides services to autistic, schizophrenic

and severely emotionally disturbed children. At a descriptive level, the children typically manifest some of the following problems: muteness, echolalia, psychotic speech, gaze aversion, social isolation (autism), temper tantrums, aggression, self-destructive behavior and inappropriate social interactions. Typically, the children are also deficient in academic and self-help skills.

The goal of the unit's program is to provide intensive services to help the child return to his

school system and participate in the special-education facilities available. Thus, the unit functions as the first stage of remediation to prepare the child for the special-education classroom. Therefore, the treatment priorities stress the elimination of aggressive, self-destructive and tantrum behavior patterns and the acquisition of speech and basic language skills and of social, self-help and play skills, as well as readiness skills (i.e., prolonged attention, following simple directions, being able to work in both a group setting and independently and simple discriminations).

The treatment of such children has historically been a difficult problem. The unit has been able to amass substantial resources to confront these disorders. As an example, the size of the professional and parapro-





professional staff is such that there are as many staff members as children. Thus, much of the therapeutic and educational interactions are conducted on an individualized, one-to-one basis.

Such a program requires extensive collaboration among all staff members to ensure consistency, and the amount of information collected each day on each child for each specific therapeutic and instructional program is extensive. Indeed, it is not unusual to record behavior episodes on a minute-by-minute basis and learning acquisition information on an individual response basis. Thus, several hundred pieces of information are collected on each child each day.

In order to improve the efficiency of the staff, provide them with accurate, properly analyzed and current information and to relieve them of certain aspects of routine data analysis and administrative burdens, we implemented a multi-user micro-computer system. Since the physical plant of the unit is extensive—encompassing approximately 22 rooms—it was essential that the per terminal cost be kept low. It was also critical that the system be easy to use, given the number of people who would be utilizing the system.

### Computer Functions

Any staff member may interrogate the system concerning the current status of any child, unless selected, confidential aspects of the file are locked for controlled access by senior staff. Information on-line for each child includes schedule information, program history, medical information and bar graph displays of specific data sets. Each data set in our specific implementation may contain up to 200 data points as well as relevant text information. Scaling of data for graph display is done automatically or may be overridden manually at the terminal. By using data compression techniques and byte-level addressing of disk files, you can store over 300 such data sets on-line on the system.

Program history contains a

description of each clinical and educational treatment program, its start date, end date, degree of success and status (active or terminated). Schedule information contains a breakdown of scheduled activities for each child by the half hour for each day of the week. Medical information specifies important data, such as specific allergies, medication type and dosage and dietary restrictions, needed on a day-by-day basis.

The system also monitors time of day, operating a prompt system for schedule changes, indicating when activities should start and stop, typically on the half hour. In addition, the system can prompt the staff at special times during the day, such as when medication is to be dispensed or other time-dependent actions are to take place. In instances of prompted functions, the terminal utilizes a visual display of information plus an audio signal that associates a specific tone with each function, so that staff need not be initially visually oriented to the terminal in order to be made aware a function is engaged.

In the event of an emergency, a staff member can press the number 9 on the keypad to summon the instant response of support and supervisory staff. This engages a warble tone at all terminals and displays a floor plan of the unit on the screen and a flashing asterisk (\*), indicating the source (see Example 1). The alarm will continue until it is reset from that room by an assisting staff member. The system logs the time and location of the incident on a printer.

In addition, other specific events can be automatically logged and printed, specifying the time, location, child involved and specific behavior displayed.

This data-logging occurs when a staff member indicates a selection—via keypad—from the menus of children and behavior that appear on the screen in specific therapy rooms. The location and child information is stored on-line, so that each room has a unique menu reflecting the specific children present.

```

condition : RED      emergency in :ACADEMIC CLASSROOM
+-----+-----+-----+-----+-----+-----+
|         |         |         |         |         |         |
|         |         |         |         |         |         |
|         |         |         |         |         |         |
|         |         |         |         |         |         |
|         |         |         |         |         |         |
+-----+-----+-----+-----+-----+-----+
344      346      348      350      352      354      356      358      360      362
***** SUPERVISORY STAFF RESPOND IMMEDIATELY *****

```

Example 1. Emergency display.

```

MESSAGE FOR STAFF - - - PLEASE RESPOND

TIME IS - 1: 33

*****

Dr. Romanczyk to the PLAYROOM

This request is :IMPORTANT

*****

1= ON MY WAY   2= COMING SOON   3=BUSY   4= NOT HERE

***** REPLY IS *****
ON MY WAY

```

Example 2. Intercom/paging display.

Since there is a large number of staff members and a visual and auditory cuing system is the best method of locating a staff member and routing him to the proper room, an intercom/paging function was included (see Example 2). The system displays a menu of names and possible messages (e.g., "urgent," "telephone call," "at convenience"). After the person summoned makes a selection, a tone is transmitted to all terminals and the visual message is displayed until a response is entered, indicating the availability status of the requested person. All responses are visible at all terminals so that alternate staff can be alerted to the request.

### Hardware

The major components of the system include an S-100 computer with disks, such as North Star, Cromemco or Processor Technology. We utilized a Sol computer with two dual-density North Star 5 inch disk units and a Model 43 Teletype (see Photo 1). Because the system was

designed for ease of implementation and fast modification, we chose an interactive BASIC for programming. Although it takes milliseconds to process each program statement, this does not degrade the response time of the system. While BASIC language programming uses additional memory for overhead, requiring almost 40K for the complete package, its flexibility and ease of quick modification more than compensate for these shortcomings.

For our purposes, we used a simple, resettable 16-bit counter with a free-running .1 or 1 second time base as a real-time clock providing time of day and interval timing capabilities. Except for the serial ports, used by the programming console/printer, all keyboard data from the 16 stations is handled by two 8-bit parallel input ports and two 8-bit parallel output ports. Video and audio switching are accomplished by latched output ports directly driving 5 V reed relays.

The keyboards use a common bus line, so that only one station may interrogate the system at a



```

condition : GREEN          MONDAY    5,28,79
.....
Program change in effect for Bryon,Tara, and
Aaron ----- Check with your supervisor and the
program change log.

Staff meeting will be delayed 1/2 hour this
week ONLY. Prepare for discussion of IEP
progress update.

Russ will update histograms at 3:00 today.

.....
>>>>>> My status is : CLEAR    I am available for your use

```

Example 3. General message display.

time. A single-gated tone generator/amplifier is used to output a beep whenever any key is pushed. This not only provides keypress feedback, but also alerts other stations that the computer is in use. An output bit is used to switch a resistor in the tone generator changing the frequency, and a second bit gates the 1 second time base into the tone generator, thus automatically producing a series of pulses without requiring software timing. These bits

allow the tone system to produce many types of audio feedback, each used for a different auditory prompt function.

We implemented each station (terminal) with a low-cost touch-tone-like keypad for input and a TV monitor linked to a 64-character-per-line-by-16-lines memory-mapped video system in the computer. We modified a Zenith J-121 TV by cutting a wire connecting the if strip and the first video amplifier and then terminating the video amplifier input

on the rear of the case.

This TV sells for approximately \$90 and uses a power transformer for isolation. The keypad is a non-encoded Automatic Electric unit selling for under \$10. The memory-mapped display is fast, filling the screen with information in less than one second (approximately 2000 cps). In addition, it allows high-speed, limited graphic displays by filling specific memory locations and makes updating of special fields easy.

Up to 16 keypads can be connected to provide one-out-of-10 code and a corresponding data available pulse, each feeding a common bus line, daisy-chained between the stations. Each keypad has ten DPST buttons wired as shown in Fig. 1. When a button is pressed, one pole is used to ground the appropriate bus line, which is held at +5 V through a 100 Ohm resistor on the interface card. The other pole is wired in common with all buttons on the keypad so that if any button is pressed, a data

available pulse will be generated.

This bus structure has proven to be completely noise immune, even though we have used over 1000 feet of cable in our installation. Previous attempts at a bus using Tri-state logic did not prove acceptable.

The data available line from each station is terminated in a 16-line-to-binary converter providing the 4-bit address of the keypad. These bits, along with the 4-bit number of the key provided by the bus interface using the 74147 decoder IC, are input to an 8-bit port. Thus, on a keypress, a simple read and decode operation will provide both the station location and the digit. We used a software loop that requires two successive inputs of the same value to further reduce the possibility of noise.

Two memory-mapped video boards are connected to SPDT reed relays so that the output of either board can be switched to the monitors at any one station or group of stations. Under stan-

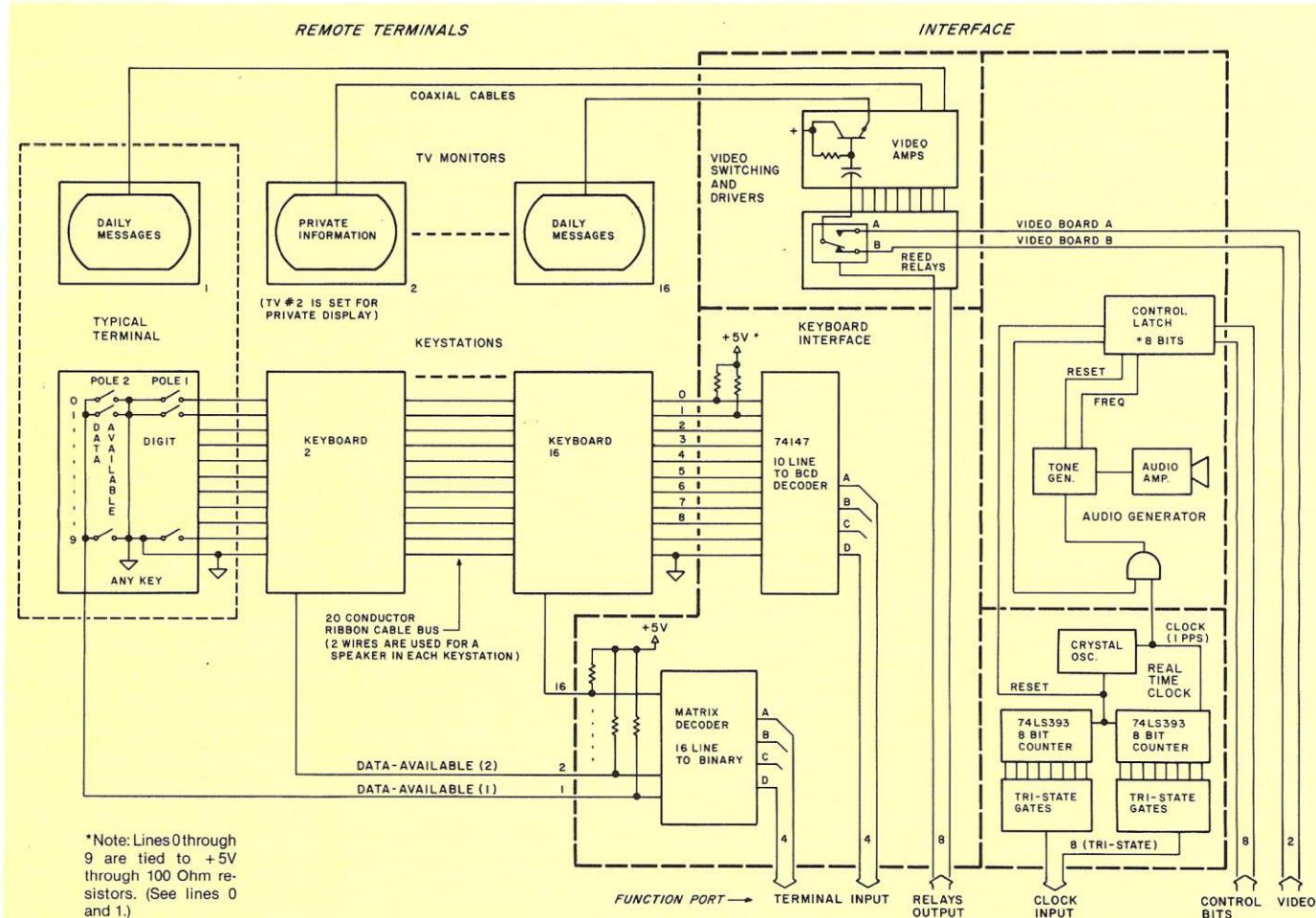


Fig. 1. Remote terminals interface.



dard operating conditions, the normally closed contacts connect video board #1 to all monitors. Because the cable length between the computer and the monitors is long, the common pole of each relay drives a simple one transistor video amplifier, isolating each terminal and reducing interference that sometimes occurs when many monitors are connected in parallel.

If text is loaded into video board #2 and a relay or group of relays is closed, those monitors will display that information. This allows one board to be used for displaying general messages, systems status and time-dependent information, while the second board can be switched to provide private information to a requesting station.

While this method only allows one private display, the addition of extra video boards and relays would provide simultaneous access to special data by more than one station. Each keypad can be equipped with a multi-digit latched numeric display and an internal tone generator/speaker, making it ideal for such uses as timing and status reporting independent of the video system.

### Software Organization

Once the program is started, all ports are initialized, the clock is set, and general messages are displayed on video board #1. Changes in the schedules and prompts are entered, and the program waits for a terminal request. During this wait time, many internal functions are being run. The clock is read and real time is updated on the monitors by directly writing into the memory-mapped display RAM. An array of special times is checked for a match, signaling a prompt display. A series of moving asterisks (\*) is written on the bottom of the screen to indicate that the system is operational. During wait times, you can activate two special functions that allow recording of event data and printing of reports using a spooler.

When a button press is de-

coded, a menu for that function is displayed. The type of function determines if a private display is necessary or if all terminals should see the information. As an example, if button 0 is pressed, a menu of names and corresponding two-digit numbers appears on the screen. The system awaits a two-button keypress to define the child file that is to be interrogated and then opens his file.

A secondary menu appears on the screen providing a selection of the displays available. Another button press displays the requested information. During this time the clock is still read, and a higher priority function can override the current display. For example, a 9 button (emergency) will override any display.

### Administrative Functions

In addition to the real-time operation of the computer system, it is also responsible for the preparation of budget projections, expense analyses and inventory control. Furthermore, the staff utilizes the computer system to prepare weekly child progress reports that can be forwarded to parents and relevant authorities. The software enables the user, by a single command, to search all child files and automatically format and

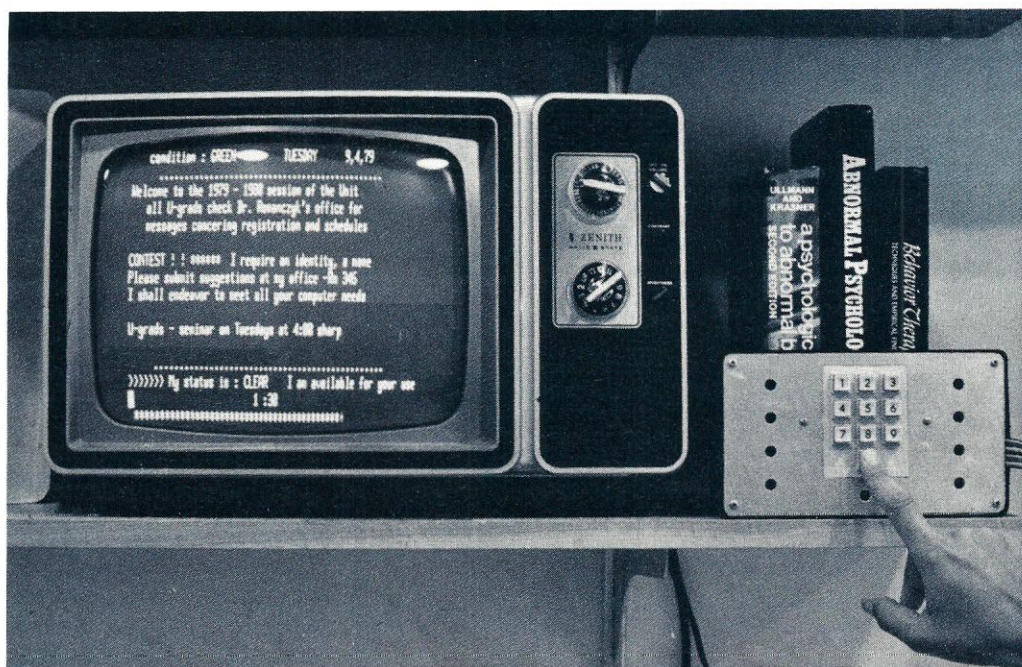
print a report specifying all elements of the current schedule, program history and medical status as described above. It is also utilized as an extensive index system for cataloging professional literature as it relates to treatment issues and basic research, as well as a word processor for the preparation of reports and manuscripts.

Additionally, the system is also used for complex analyses of child behavior. It is possible for staff members to enter observational data in 10-second bit format and have the computer provide them with a statistical analysis, such as conditional probabilities, phi coefficients or interrelationships among the

discrete behavior patterns and overall frequency and distribution.

Perhaps one of the most important uses occurs at weekly staff meetings. Each child may be reviewed, with instant access to all relevant information, especially the bar graph displays, in much more depth and with greater speed than is typically possible. A large 25-inch monitor is present in the staff room, allowing all staff members to simultaneously view the information being presented.

In the past, review of all children would have to be spread over five to six weeks due to preparation time and the cumbersome aspects of pre-



TV monitor and keypad.

PLEASE INDICATE YOUR CHOICE - - 1=ACTIVE 0=TERMINATED  
5= ALL PROGRAMS

|   |   |
|---|---|
| 10/28/78 ELIMINATE AGGRESSIVE BEHAVIOR                    | 1 |
| 2/1/79 IMPROVING ARTICULATION (FOOD ITEMS)                | 1 |
| 9/28/78 LANGUAGE AND READING SYNTAX - REBUS SERIES        | 1 |
| 9/27/78 COLOR ID WITH PRONOUNS                            | 1 |
| 3/26/79 DEVELOPING SPONTANEOUS SPEECH (4 WORD PHRASES)    | 1 |
| 9/25/78 ELIMINATE DISRUPTIVE BEHAVIOR (INDIVIDUAL LANG)   | 1 |
| 9/25/78 ELIMINATE AGGRESSIVE BEHAVIOR (INDIVIDUAL LANG)   | 1 |
| 2/29/79 INDEPENDENT ATTENTIVE SKILLS (STUFFING ENVELOPES) | 1 |
| 2/28/79 DESCRIPTIVE SPEECH (PRONOUNS)                     | 1 |
| 3/26/79 SIGHT VOCAB (RESPONDING TO FUNCTIONAL SIGNS)      | 1 |
| ***** Press 0 to continue                                 |   |
| 3/28/79 COOPERATIVE PLAY (GAMES AND EXERCISES)            | 1 |
| 3/28/79 ELIMINATE SIB                                     | 1 |
| ***** PRESS 7 TO CLEAR                                    |   |

Example 4. Sample of child's programs.



# PPI-80 PARALLEL I/O FOR THE TRS-80

The PPI-80 is a complete parallel I/O interface designed specifically for the TRS-80, consisting of 3 complete 8 bit I/O ports including such features as:

- \* switch selectable address decoding
- \* complete on board regulated power supply
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- \* on board kluge area for experimenting
- \* provisions for interfacing Sears-BSR-RS home controller

## Possible applications include:

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- \* parallel printer interface
- \* wireless home control via BSR home controller
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- \* interfaces to many popular boards including A/D-D/A converter and an EPROM Programmer

## PPI-80 is available now and can be purchased in several forms

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 Bare board drilled and etched with assembly manual ..... 25.95  
 Accessories:  
 8 channel A/D - 2 channel D/A by Optimal Technology .....\$115.00  
 EPROM Programmer Model EP-2A-79 by Optimal Technology .....\$155.00

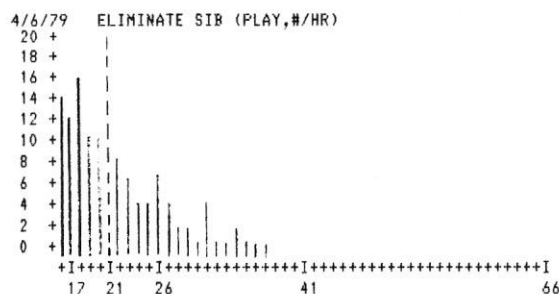
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S.C. residents add 4% sales tax  
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 charleston sc  
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Example 5. Sample histogram.

senting this type of information. Thus, we are now able to review the children much more frequently than in the past, enabling us to provide greatly improved service delivery. The system is also useful in providing parents with up-to-date information at a moment's notice during visits to the unit.

The system has now been operational for two years, and there have been no failures whatsoever. The system as proved easy to use by the staff, which has responded enthusiastically

to its implementation. Indeed, it requires only 10-15 minutes of instruction for a staff member to use the basic system, with perhaps an additional 1/2 hour to master all the off-line functions. The system has greatly enhanced the operation of the unit and is now an integral part of the organizational and therapeutic structure.

We wish to thank Micro World Computer Store in Johnson City NY for their assistance in the design of the hardware and software used in this system. ■

## THE ULTIMATE TRS-80 SPEED-UP!

Mumford Micro Systems announces the release of the SK-2: The most versatile clock modification for the TRS-80 available. It features three speeds: normal (1.77MHz), 50% faster, or 50% slower; selectable at any time without interrupting execution or crashing the program. It may be configured by the user to change speed with a toggle switch or on software command. It may be tied to the expansion interface and will automatically return to normal speed anytime a disk drive is active. It even has provisions for adding an LED to indicate when the computer is not at the normal speed. It mounts inside the keyboard unit with only 4 necessary connections for the switch option (switch not included), and is easily removed if the computer ever needs service. The SK-2 comes fully assembled with illustrated instructions for implementing the various options and complete satisfaction is guaranteed....\$24.95

### DUPLICATE SYSTEM TAPES WITH "CLONE"

This machine language program makes duplicate copies of ANY tape written for Level II. They may be SYSTEM tapes (continuous or not) or data lists. It is not necessary to know the file name or where it loads in memory, and there is no chance of system co-residency. The file name, entry point, and every byte (in ASCII format) are displayed on the video screen. Data may be modified before copy is produced. CLONE....\$16.95

### RAM TEST FOR LEVEL II

This machine language program tests memory chips for open or shorted address or data lines as well as intermittents. It tests each BIT for validity and each BYTE in the execution of an actual instruction as in real program execution. Bad addresses are displayed along with the bad data and proper data. One complete test of 48K takes just 14 seconds. Also includes a test for errors induced by power line glitches from external equipment. RAMTEST....\$9.95

### PROGRAM INDEX FOR DISK BASIC

Assemble an alphabetized index of your entire program library from disk directories. Program names and free space are read automatically (need not be typed in) and may be alphabetized by disk or program. The list may also be searched for any disk, program, or extension; disks or programs added or deleted; and the whole list or any part sent to the printer. Finally, the list itself may be stored on disk for future access and update. One drive and 32K required. INDEX....\$19.95

### EDIT BASIC PROGRAMS WITH ELECTRIC PENCIL

This program allows disk users to load Basic programs or any other ASCII data file into the disk version of Electric Pencil for editing. Now you can edit line numbers, move program segments, duplicate program segments, and search for the occurrence of any group of characters. PENPATCH....\$9.95

### SPOOLER FOR PARALLEL PRINTERS

This program is a full feature print formatting package featuring user definable line and page length (with line feeds inserted between words or after punctuation), screen dump, keyboard debounce, and printer pause control. In addition, printing is done from a 4K buffer area so that the LPRINT or LLIST command returns control to the user while printing is being done. Ideal for Selectric or other slow printers. Allows printing and processing to run concurrently. SPOOLER....\$16.95

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**WANTED: DIGITAL** Group 32K memory board without memory chips and Phi deck controller board (kit, assembled or not working). 1510 NW 35th.

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# EXATRON STRINGY FLOPPY

## Owners Association Newsletter

Secretary, Fred Waters

### WHAT'S A STRINGY FLOPPY?

This little Magic Box has been around for a while now, but personal computing continues to grow at an astounding rate, and there are a lot of newcomers that may not yet have heard of the Exatron Stringy Floppy—ESF for short.

The ESF is a mass storage subsystem for your microcomputer. It does basically what either an audio-type cassette or a disk system does—provide offline storage of programs or data. When you want to save a program now in your system memory, or save data developed within a program, such as the names and addresses that make up a mailing list program, or the record of past bowling scores and averages for a bowling league secretary's program, you need a convenient way to do this. You may have discovered by now that cassettes are slow, sometimes difficult to load and save, cumbersome to verify, and generally less reliable and convenient than you'd like. You probably have already noticed that disk systems, although fast and more reliable, are quite costly, often to the point of requiring an outlay more than the total cost of your system to date.

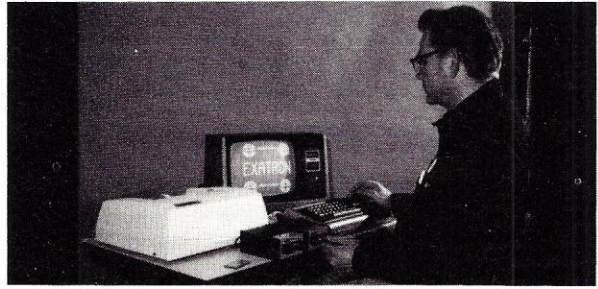
Well, the ESF gives you a great leap forward in reliability and convenience over the cassette, at something less than a quarter the cost of a disk system. There are three versions now being marketed—for S-100 systems, for the SS-50 bus, and for the TRS-80. The original version was the S-100, introduced at the 2nd West Coast Computer Faire in February 1978. Your secretary has been using this version with his IMSAI 8080—with of course successive product improvements—for about two and a half years now. Jim Maynard in Oklahoma liked the ESF, but wanted one for his SWTP micro and the 6800 CPU. So he designed it, came to Santa Clara in early 1979 to complete the development, and as Exatron project manager for the SS-50 version, introduced it at the 4th West Coast Computer Faire in

May 1979. Meanwhile the demand for a TRS-80 version swelled; this version also was developed in the spring of '79, and was likewise introduced at the Faire in May. All three versions are currently available, with a 6502 version in the mill.

### HOW DOES IT WORK?

The ESF consists of small case, about 4"x6"x2½", with a drive slot in the front face, two LED indicator lights, and inside the drive mechanism, tape read and write heads, and some electronics. The S-100 and SS-50 versions have ribbon cable connections to a controller board on the motherboard, and are thereby powered and controlled. The TRS-80 version has its own wall-plug transformer and power and all the firmware and control electronics are in the case, with the drive. The storage medium is digital-quality magnetic tape on a continuous loop within a miniature cartridge called a wafer. The wafer is about 3/16" thick and smaller than a business card. Tape lengths vary from 5 to 75 feet. Single-density storage and loading handles 4K bytes on 5 feet of tape in 6 seconds. That's 7200 baud, as compared to 500 for the standard cassette machine. This means that the program you now load in about two minutes—with three or four minutes more for rewind and verification—can be accurately and reliably loaded in about nine seconds! Fred Blechman, Canoga Park, CA, author and inventor and one of our most articulate boosters, says, "The simplicity and speed of operation make the Stringy Floppy compare to a cassette recorder like a modern car compares to a horse and buggy!"

All ESF operations are controlled by software commands—there are no switches, buttons or other physical controls. Two modes of error detection are designed into the controls for loading. Byte-by-byte verification is provided after any save operation. New tapes are verified from end to end to ensure error-free operation. Multiple programs can be loaded onto one wafer, and



Pictured above is Bill Burnham, from Redwood City, California; just a few miles north of EXATRON here in Santa Clara. Bill is an electronics technician specializing in electronic musical instruments.

Bill says it was the Stringy Floppy that really created his inspirations to write, as it made programming so easy and fast that it now is all a labor of love.

called up individually by file number. To put it simply, the ESF is easy to use, most convenient, and highly reliable. IT REALLY WORKS GREAT!

But look—we're getting carried away. We can only begin to tell you here about all the features—double-density for instance in both the S-100 and SS-50 versions, and in the works for the TRS-80 version—so call us at the toll-free number below and ask for our ample information packet.

### THE WORKSHOP PROGRAM

Since January 1978 there has been a Saturday morning workshop at the Exatron plant for anyone owning or interested in the ESF. This idea has been so remarkably successful that it had to spread. Meanwhile the technical and commercial track record of the ESF has resulted in ownership of at least several ESFs in every significant population center in the U.S. Owners were asked about the workshop idea, and we now have a network of Workshop Program Chairmen all over the country. If you call our toll-free number below, not only will you get the info packet, you will also get the name of the nearest Workshop Chairman, who is prepared to answer your questions about the ESF, and with notice to conduct an informal workshop meeting and demonstrate the Stringy Floppy in action.

### MICRO-COM ACQUISITION

Until recently Exatron production and expansion has been limited or blocked by dependency on the vendor of the drive and the wafers—they just couldn't keep up with the ultimate customer demand. You owners are building up libraries of software on ESF wafers, and you need more of them. You newcomers to personal computing are pushing production to satisfy the demand for the ESF. Whadda y'do in a spot like this? Acquire 'em! In February Exatron closed the deal to acquire the capital assets of Micro Communications Corp. in Waltham, MA; as of the end of February the wafer backlog is getting under control and ESF production and delivery is being accelerated. By the time you read this our hotline response to your question "How long before I can get it?" will be a reasonable one.

### INFORMATION & ORDERS

The ESF is assembled and tested at the factory, with a 30-day moneyback guarantee and a one year full warranty. For fastest delivery, phone in your credit card or COD order using the toll-free line below.

Base price for the TRS-80 ESF, \$249.50 (ask about the Starter Kit); for the S-100 ESF, \$289.50; and for the complete SS-50 package (described in detail in last month's N/L), \$499. Info packets at no charge; users manuals for the TRS-80 ESF are available for \$3.00 shipping.

Handling is extra.

If you have any questions about these products, about Exatron or about ESFOA call the Hot Line. Address letters to ESFOA, 3555 Ryder St., Santa Clara, CA 95051.

Stringy Floppy is a trademark of Exatron Corporation.

**HOT LINE**

**800-538-8559**

**WITHIN CALIFORNIA**

**408-737-7111**



# EXATRON STRINGY FLOPPY

## WORKSHOP CHAIRMEN

Listed below are the names and phone numbers of ESFOA Workshop Program Chairmen. If you have any questions about the Stringy Floppy or wish a demonstration of the equipment, please contact the chairman for your area.

### WORKSHOP CHAIRMEN (Listed by Zip Code)

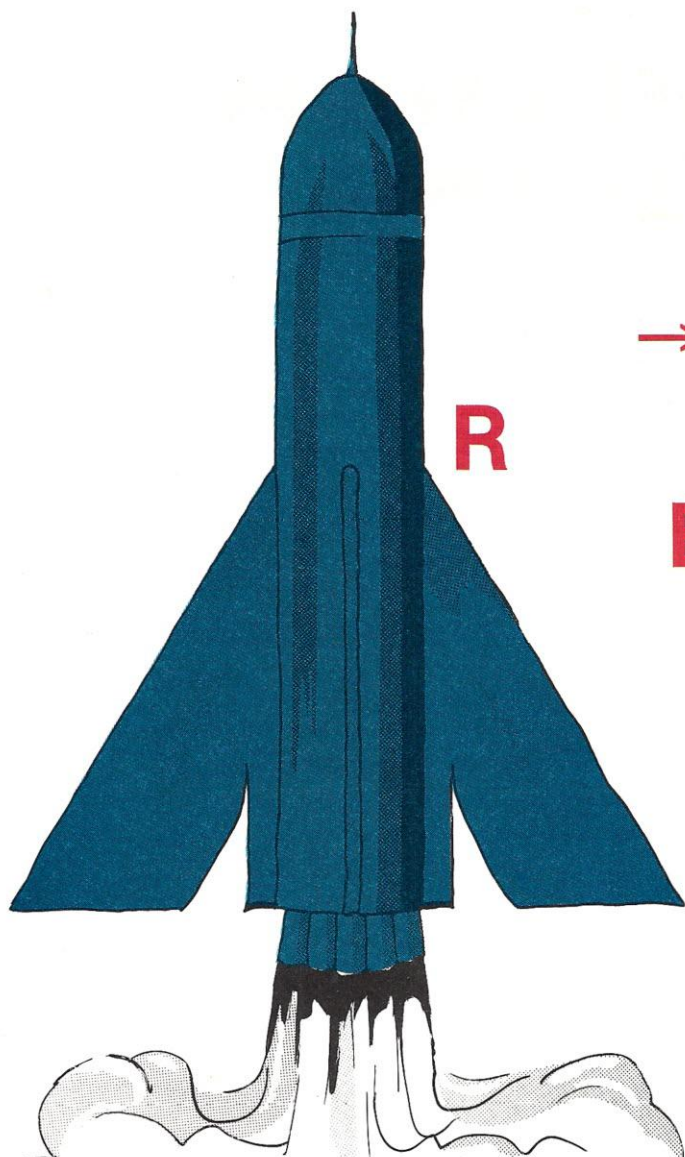
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 Austin McCollough, 24 Donna Rd., Chelmsford, MA 01824 (617) 256-0473  
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 Wesley R. Day, 86 Merryfield Ave., Waterville, ME 04901 (207) 873-3955  
 Rev. Richard R. Noyes, 118 Main Street, Madison, ME 04950 (207) 696-5929  
 Michael Keller, RFD 1, Box 507, Solon, ME 04979 (207) 643-2437  
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R



E

O

TRS-80  
Level II

T

R

I

B

Terry Kepner  
Bud Grace  
P O Box 481  
Peterborough NH 03458

```

5 REM ORBITER PROGRAM
10 CLS
15 REM TURN ON SUN IN SCREEN CENTER
20 SET(63,23)
25 REM SET ENGINES (IN EARTH GRAVITIES)
30 A= 5
35 REM SET SUN'S GRAVITY
40 G=50
45 REM SET INITIAL SHIP POSITION
50 X=-30:Y=-20
55 REM CHECK KEYBOARD FOR INPUT
60 K$=INKEY$
65 REM COMPUTE CHANGES INTRODUCED BY ENGINES
70 IF K$="J" THEN DX=DX+A
80 IF K$="F" THEN DX=DX-A
90 IF K$="B" THEN DY=DY+A
100 IF K$="Y" THEN DY=DY-A
105 REM COMPUTE SUN'S PULL ON SHIP
110 X1=X+X
120 Y1=Y+Y
130 Z1=X1+Y1
140 D=G/(Z1)^(3/2)
150 FX=-X*D
160 FY=-Y*D
165 REM COMPUTE CHANGES IN SHIP'S COURSE
170 DX=DX+FX
180 DY=DY+FY
185 REM TURN OFF OLD POSITION ON SCREEN
210 RESET(H,V)
215 REM COMPUTE NEW POSITION
220 X=X+DX
230 Y=Y+DY
235 REM TURN ON NEW SCREEN POSITION
240 H=2*X+63
250 V=Y+23
260 SET(H,V)
270 GOTO 60

```

Listing 1. Orbiter program.

Ever since I first used an interactive computer, I have been playing different versions of the Lunar Lander game (lunar excursion module). All of these versions started from the same premise: The LEM is x miles/feet away from the landing sight and y miles/feet above the surface, with a horizontal velocity of dx feet per second.

None of these versions has really approached a true simulation. Even when I was using the DEC-10, the best version of the game began in this manner, although it did restrict the player to only those parameters and thrust values used aboard the actual LEM.

After having an R/S L II for almost a year, I decided to try to program a LEM simulation that not only retained the true parameters, but also started out

in a true orbit from which the player had to try to land the LEM.

Two weeks later my room was waist deep in paper, and I had run out of hair to pull out in frustration. I just couldn't make my equations work properly, and none of my textbooks helped. At about this time I mentioned my difficulties to a friend of mine, Bud Grace. Eureka!

Not only could he help me with the equations, but he already had a program capable of evaluating orbits. The program, cleaned up and with REM statements added, is shown in Listing 1.

#### How the Programs Work

Upon inspection you'll note that the gravity of the central sun (or black hole, if you prefer) is set at 50 times that of the Earth, and the acceleration of the rocket's engines is set at one half that of the Earth's gravity. For simplicity and to speed up the computations, the mass of the central sun and the rocket are assumed to be equal, unit mass one. Also, instead of using a differential equation, a simple summation process is used,



again for speed in running. Despite these shortcuts the orbits established can be stable for over a 1000 revolutions.

The game starts with the rocket in the upper left-hand corner of the screen, at a dead stop with relation to the central sun. It will free-fall toward the sun, as you hit the proper keys to fire the engines and try to set up an orbit.

One other point to notice is that the position of the rocket on the screen has been corrected for the difference in x-y axis spacing (lines 240 and 250); that is, a circle on the screen is really a circle and not an ellipse distorted to appear as a circle. And last, the program crashes if the rocket tries to leave the screen.

Listing 2 is an improved version of the orbiter changed into a simple game. The screen limitation has been removed, and the x-y coordinates of the rocket are displayed in the upper left corner of the screen whenever the rocket does leave the screen. For ease of use, the direction keys have been changed to use the keyboard arrows.

The game feature involves the use of orbital bombs created by the computer and dropped onto the screen with random velocities. If one of these bombs comes within range of the rocket, the rocket will blow it up. Only one bomb is allowed on the screen at a time. To control the frequency that these bombs appear, a number between 1 and 50 is chosen by the player at the beginning of the game. Choosing 1 ensures that there will always be one bomb on the screen, while choosing the 50 means that once every 50 screen updates a bomb should appear, on the average.

Referring back to Listing 1, you might try removing the reset (line 210) and watching how the orbits precess around the sun. When this is done, you will notice that no matter how elliptical the orbit may appear at first, as time passes, the orbital pattern is symmetrical. This precession is normal for all orbits and may require as many as 2000 orbits to precess in a complete 360° circle. ■

```

10 CLS
20 REM BY BUD GRACE
30 PRINT"ORBITER"
40 PRINT
50 REM DIRECTION CONTROLS
60 PRINTCHR$(91); " = UP"
70 PRINTCHR$(92); " = DOWN"
80 PRINTCHR$(93); " = LEFT"
90 PRINTCHR$(94); " = RIGHT"
100 HO=40
110 VE=30
120 PRINT
130 REM THIS CONTROLS THE BOMBS. 1=ALWAYS A BOMB, 50=RARELY
140 INPUT"WHAT LEVEL OF DIFFICULTY DO YOU WANT (1 - 50)";TY
150 REM SET CONSTANTS AND INITIALIZE THE VARIABLES
160 Q=3/2
170 E=31
180 B=23
190 C=63
200 R=2
210 CLS
220 REM SET THE SUN
230 SET(C,B)
240 A=.5
250 G=30
260 X=-29
270 Y=-20
280 REM CHECK KEYBOARD FOR INPUT
290 K$=INKEY$:IF K$="" THEN 320 ELSE K$=ASC(K$)
300 REM COMPUTE CHANGES INTRODUCED BY KEYBOARD
310 IF K$=9 THEN DX=DX+A
320 IF K$=8 THEN DX=DX-A
330 IF K$=10 THEN DY=DY+A
340 IF K$=91 THEN DY=DY-A
350 SW=X
360 SU=Y
370 REM CALCULATE ACCELERATION DUE TO GRAVITY
380 GOSUB 740
390 REM UPDATE VARIABLES
400 FX=-X*D
410 FY=-Y*D
420 DX=DX+FX
430 DY=DY+FY
440 REM IF THERE ISN'T A BOMB, THEN IS IT TIME FOR ONE?
450 IFFLAG=0 THEN TEST=RND(50+TY/50)
460 IFFLAG=10 THEN TEST<1 THEN 460
470 REM IF IT IS TIME, THEN CREATE ONE
480 HO=RND(C)-E
490 VE=-B
500 DH=RND(3)-R
510 DV=RND(5)-3
520 FLAG=1
530 REM IS THERE A BOMB ON THE SCREEN
540 IFFLAG=0 GOTO 660
550 REM IF SO, THEN UPDATE ITS POSITION
560 SH=HO
570 SV=VE
580 REM ACCELERATE THE BOMB
590 GOSUB 740
600 DH=DH+HO*D
610 DV=DV+VE*D
620 HO=HO-DH
630 VE=VE-DV
640 REM IF ITS NEW POSITION IS OFF SCREEN, DESTROY IT
650 IF ABS(HO)>E OR ABS(VE)>B THEN FLAG=0: RESET(H1,V1): GOTO 660
660 REM TURN OFF BOMB'S OLD MARKER
670 RESET(H1,V1)
680 H1=R*HO+C
690 V1=VE+B
700 REM TURN ON BOMB'S NEW MARKER
710 SET(H1,V1)
720 REM TEST TO SEE IF ASTRONAUT IS WITHIN RANGE
730 IF (ABS(HO-X))>40 OR (ABS(VE-Y))>2 THEN GOTO 660
740 REM IF YES THEN BLOW HIM UP
750 PRINT00;"YOU ARE A DEAD ASTRONAUT -- YOU SHOULD BE MORE CAREFUL"
760 PRINT"DO YOU WANT TO TRY AGAIN?";
770 GOSUB 760
780 K$=INKEY$
790 IF K$="" THEN 620
800 IF K$="Y" OR K$="YES" THEN RUN
810 END
820 REM IF THE SHIP IS ON THE SCREEN, TURN OFF ITS MARKER
830 IF ABS(X)<E AND ABS(Y)<B THEN RESET(H,V) ELSE PRINT00; CHR$(30)
840 X=X+DX
850 Y=Y+DY
860 H=R*X+C
870 V=Y+B
880 REM TURN ON ITS NEW MARKER
890 IF ABS(X)<E AND ABS(Y)<B THEN SET(H,V) ELSE PRINT00; INT(X); INT(Y)
900 REM IF TOO CLOSE TO SUN, DESTROY SHIP
910 IF ABS(X-C)<4 AND ABS(Y-B)<2 THEN 600
920 GOTO 270
930 REM THIS COMPUTES THE EFFECT OF GRAVITY
940 D=(G/(SW*SW+SU*SU))*.1
950 RETURN
960 REM THIS EXPLODES THE SHIP
970 FOR J=H-3 TO H+3 STEP 2
980 FOR I=V-2 TO V+2 STEP 2
990 SET(J,I)
1000 NEXT I, J
1010 RETURN

```

Listing 2. Improved version.



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# Wire Listings the Easy Way

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Jack G. Sheppard, Ph.D., P.E.  
5242 Laguna  
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I always solder connectors on both ends of the cable before slipping the shells on. Last night I even discovered a variant of the procedure. Forced by the Lady of the Manor to move the computer from the living room, I had to install a stereo outlet in the wall of its new quarters.

Immersed with total concentration in the project, I mated a phone jack to the new cable and looked around for the wall plate. It was on the wall. The wires on which I had just soldered the phone jack protruded neatly through its hole. The phone jack, which is supposed to mount behind the plate, is larger than the hole in the plate.

Did I unsolder the phone jack and calmly reinstall it correctly, or did I break the plate? I can testify that the plastic wall plates shatter most satisfyingly when attacked with diagonal cutters.

## Introduction

There are lots of us computer owners who are afflicted with constructional klutzomania. At the same time, there are lots of gadgets we would like to have for our computers that we probably can't afford to buy. Our only alternative is to build them.

And why not? Microcircuits virtually paper the walls of every radio and computer store. If you hook a few together, they will do anything you want. Designing the logical circuit is no problem... certainly no more diffi-

cult than designing the programs we feed to our computers.

But think of all those wires! Even a small project will necessitate several hundred connections. And what about the klutzomaniac?

The rest of this article describes a program that generates easy-to-follow wire-connection lists. I have completed two major construction projects using this program without a single wiring error.

## The Program

The program was written for the Level II TRS-80, although it can be adapted to any computer that allows arrays. It will prompt you through the process of developing the listing so that you have a minimum chance of making errors. It keeps track of what chip you are working on and

which pins have already been treated, so that you don't end up wiring the same circuit twice. It will also ensure that no pin is ignored. At the end, you will have a list of pin-pairs on the construction board that you can wire directly with confidence.

Begin any construction project with a clean logic diagram on which each chip, along with each of its pins, is displayed. Number each chip. Show the wiring destination of each pin, either by drawing in the wire or by listing destination chips and pins.

Next, lay out the construction board. Chips should be located (not installed at this point) on the board in positions that will minimize wiring runs. Label columns of pins using letters, and label rows of pins using numbers (this is the format of an Augat wire-wrap board, which is the construction medium that I prefer).

Columns of pins on the board should align with the pins of the chips to be installed. Thus, pins 1-8 of chip 1, for example, may occupy board positions A1 through A8 (see Fig. 1). Identify and record the positions on the board of pin 1 and the highest-numbered pin of each chip. You are now ready to run the program and develop your wire list.

## Operation

After you load the program, it will ask how many chips you will be using and what the largest pin-count per chip is. This information is used to set up arrays on which the program will operate. The program will then initiate a loop that asks for the num-

ber of pins on each chip and the board locations of the lowest- and the highest-numbered pins. This information is used to set the locations of the chips with respect to the pin matrix used on the construction board. This loop also converts the column-designating letter into an equivalent number for use by the computer.

I wanted the program to guarantee that I didn't overlook any pin or wire any pin twice unless it needed it. I set up a two-dimensional array, E(I,J), to keep track of the pins used at any point in program execution. A pair of nested loops ensures that all values are zero at the outset. The program marks each pin with a nonzero value in this array as it is used.

Next, a pair of nested loops begins with chip 1, pin 1, and performs the following functions:

1. Checks whether the pin has been used. If so, goes to the next pin.

2. Asks for connection data with the statement "CHIP 1 PIN 1 GOES TO (CHIP,PIN)?" If there is no connection, enter "0,0", and the loop marks the pin and proceeds to the next pin. If the pin is to be connected, you should respond with the correct destination chip and pin. The program will mark the destination pin as having been used and print the linkage. It will then ask for any additional connections to chip 1, pin 1. You should enter all paths that can be traced to this pin. After all connections have been logged, enter "0,0". The program will mark chip 1, pin 1, "used" and

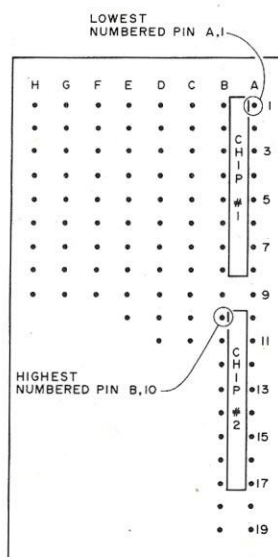


Fig. 1. Typical board layout.



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advance to chip 1, pin 2.

3. Data is entered as chip numbers and pin numbers. The construction board is laid out in lettered columns and numbered rows. Chip 7, pin 13, may be located at column F, row 45, for example. The loop converts the chip #, pin #, into construction-board format. There is one tricky operation, highly prone to manual error, and is the reason I developed this program in the first place. On a 16-pin chip, pins 9-16 number in the reverse direction from the row numbers on the construction board. In converting to board format, you must determine whether the pin is in the upper half or lower half, so that you know which column to use and whether to add or subtract to get the row number. My printer does not have less-than/greater-than symbols, so I used brackets ([,]) instead.

4. As each data-pair is logged and converted into column and row form, it is printed on the CRT. The results are not stored

in retrievable form, so you will need to copy them from the CRT as they are displayed. If you have a printer, modify statement 290 to LPRINT, and you will not need to copy the data manually.

5. This loop is not an automatic loop. It sticks with one pin until the user enters "0,0". Then it goes on to the next pin, and so on until all pins have been used and marked.

**Conclusion**

A large construction project requires that you key in a large number of data values. A computer cannot read minds and cannot identify errors that fit the prescribed form, so check the data as you key it in. If you do that and follow the resultant list scrupulously, you should have virtually error-free wiring. As a bonus, you can use a multimeter to run a quick continuity check on the wrapped board to determine whether you have put wires on the wrong pins, or vice versa. ■

```

1 REM --THIS PROGRAM CREATES WIRE LISTS--
10 INPUT "WHAT IS THE LARGEST PIN COUNT?";A1
15 REM --INPUT TOTAL NUMBER OF IC'S USED IN PROJECT--
20 INPUT "HOW MANY CHIPS?";A
30 DIM B(A),C1(A),C2(A),D1(A),D2(A),E(A,A1)
35 REM --LOOP TO SET UP LOCATION DATA FOR ALL CHIPS--
40 FOR I=1 TO A
50 PRINT "HOW MANY PINS ON CHIP ";I;:INPUT B(I)
60 PRINT "ENTER LOCATION OF CHIP ";I; "PIN 1 (COLUMN, ROW)";
65 INPUT C$,C2(I)
70 PRINT "ENTER LOCATION OF CHIP ";I; "PIN ";B(I);
75 INPUT D$,D2(I)
76 REM --CONVERT COLUMN-LETTER TO EQUIVALENT NUMBER--
80 C1(I)=ASC(C$)-64:D1(I)=ASC(D$)-64
90 NEXT I
95 REM --LOOP TO ZERO ALL PIN-USE MARKERS--
100 FOR I=1 TO A:FOR J=1 TO A1:E(I,J)=0:NEXT J:NEXT I
105 REM --CHIP SELECT LOOP--
110 FOR I=1 TO A
115 REM --PIN SELECT LOOP--
120 FOR J=1 TO B(I)
125 REM --CHECK WHETHER PIN HAS BEEN USED--
130 IF E(I,J) GOTO 310
135 REM --INPUT CONNECTION DATA--
140 PRINT "CHIP ";I; "PIN ";J; " GOES TO (CHIP, PIN)";: INPUT X,Y
145 REM --CHECK FOR CONNECTION--
150 IF X GOTO 170
155 REM --MARK PIN USED--
160 E(I,J)=1:GOTO 310
165 REM --MARK DESTINATION USED--
170 E(X,Y)=2
175 REM --CHECK WHETHER SOURCE-PIN IS UPPER OR LOWER HALF--
180 IF J>B(I)/2 GOTO 210
185 REM --LOWER-HALF CONVERSION--
190 S=C1(I)
200 U=C2(I)+J-1:GOTO 230
205 REM --UPPER-HALF CONVERSION--
210 S=D1(I)
220 U=D2(I)+B(I)-J
225 REM --CHECK WHETHER DESTINATION-PIN IS UPPER OR LOWER HALF--
230 IF Y>B(X)/2 GOTO 260
235 REM --LOWER-HALF CONVERSION--
240 W=C1(X)
250 V=C2(X)+Y-1:GOTO 280
255 REM --UPPER-HALF CONVERSION--
260 W=D1(X)
270 V=D2(X)+B(X)-Y
275 REM --CONVERT COLUMN NUMBERS TO LETTERS--
280 S$=CHR$(S+64):W$=CHR$(W+64)
285 REM --PRINT CONNECTION DATA--
290 PRINT S$;" ";U;" CONNECTS TO ";W$;" ";V
300 GOTO 130
310 NEXT J
320 NEXT I
330 END
    
```

Program listing.



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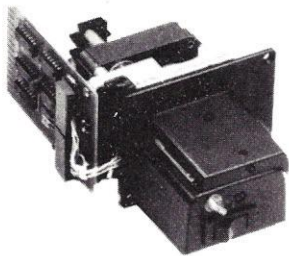
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# A Micro for the Eighties

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*That's the author's assessment of the AlphaMicro AM-100 microcomputer.*

---

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**L**ongtime readers of *Kilobaud* may remember articles by Dick Wilcox in three of the first four issues describing a complex operating system for microcomputers. Dick put his many years of programming experience not only into those articles, but also into a micro for the eighties, the AlphaMicro AM-100. As one who waited many months for this machine to become a reality, I can testify that Dick and the others at AlphaMicro have done a good job. Anyone buying this microcomputer will not be disappointed!

## Introduction

The AM-100 hardware, while quite different from the usual micro boards, is surpassed only by the excellent software supported by this system. The CPU is a Western Digital WD-16, which, with its supporting chips, is mounted on two boards that plug into the S-100 bus (see Photos 1 and 2). Although the computer is a 16-bit machine, the CPU functions with 8-bit memories and I/O boards.

As a result, you don't have to spend double or triple the going microcomputer cost for your peripherals—almost all will work. You can upgrade your 8080 or Z-80 machine to the AM-100 for slightly more than the cost of the CPU boards. If you are just starting out, there are scores of devices that will work with the AM-100 and are totally compatible with it.

The CPU has a push-down hardware stack, vectored interrupt handling, eight 16-bit registers, hardware floating-point

arithmetic and eight modes of addressing. But what really sets the AM-100 apart from the rest is the systems software that comes with it.

## Structure of the System

The standard AM-100 system, as supplied, is multitasking, multi-user, which means that several terminals can be operating at one time, handling different functions. This feature makes the AM-100 ideal for schools and for businesses that want multiple terminals on line, as well as for the personal computer user.

Each user has his own block of memory, up to 64K (not total, for each), and runs in a job area different from the other users' on the system. I have five separate jobs set up on my machine, for example. The system supervisor (that's you) can allocate jobs in just about whatever manner he wishes.

Areas of the disks are set up by the supervisor from time to time for different purposes, such as games, demonstration programs and business programs. There is no limit to the number of areas—called PPNs (Project-Programmer Number)—that you can allocate. (There is, however, a limit of 64 PPNs per disk.) Any PPN may be protected by a password to prevent unauthorized access. You don't have to allocate the number of disk blocks you want to use for each PPN; the system allocates blocks automatically as they are needed.

To keep track of all jobs, a system status display (DYSTAT) operates at all times through a video display monitor (VDM), which shows the supervisor what is going on with the system (see Photo 3). The VDM is supplied by you, but the software for

DYSTAT is part of the system. (The VDM has been discontinued. DYSTAT will, I am told, work with other available video boards.)

All system (and user) software is totally relocatable; that is, it will run anywhere in memory. This restricts writing assembly-language programs, as you cannot use any direct addressing modes. However, there are several addressing modes (not available for the 8080) that lend themselves to writing totally relocatable code.

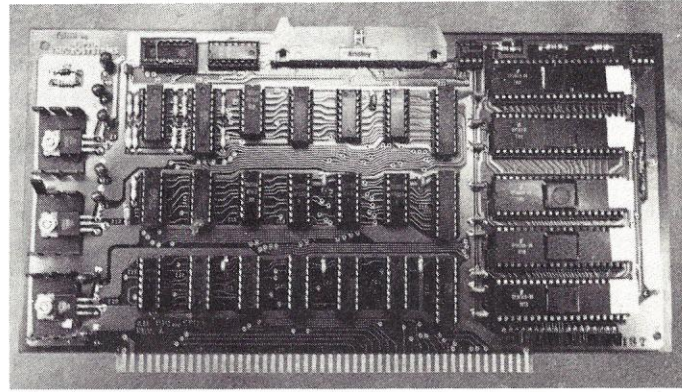
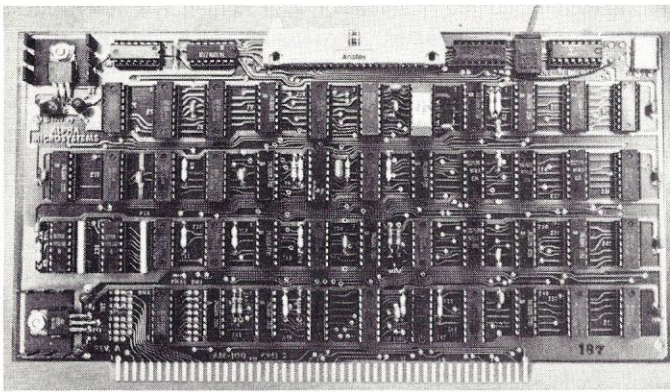
The system directs where in memory a program will end up without intervention by the operator. The system also keeps track of where your programs and data files are located on your disks. Photos 4 and 5 suggest how easy it is to use this system.

## Terminal Service System

You can interface just about any terminal to the AM-100 and use just about any I/O board. AlphaMicro furnishes drivers for many popular boards and terminals, but if they don't support the ones you have, you can attempt to write a driver yourself.

Basically, you set up a terminal definition block one time for each terminal, printer or modem board that you intend to use. This block contains a reference to the port number of the I/O board you are using, the name of the driver (short assembly-language program that initializes that board, transfers characters to and from the system and looks for a data terminal ready (DTR) signal) and the make of terminal you have attached to the I/O board. The block also contains information about the size of the input and output buffers that you want the system to allocate for communication with that terminal.





*Photos 1 and 2. The AM-100 CPU boards. The connector at the top of each board takes a ribbon cable, which interconnects the two boards. The large switch on the first board turns off the AM-100 and allows you to use your Z-80 or 8080 without removing the AM-100 from the box.*

The terminal definition block (TRMDEF) is automatically put into the system when it is booted. Thereafter, a complex, but general, terminal service system scans each terminal in the system on an interrupt schedule, taking input from each in its time-slot (or outputting to each) so that the operation is transparent to the users. This is how the big time-sharing systems work and results in a satisfactory, flexible arrangement.

### Systems Programs

There are several disk areas (PPNs) that are permanently reserved for systems programs and drivers. These come with the AM-100. On my system there are 143 programs in the system common area (accessible by all users), 46 device drivers (for terminals, printers, disks and I/O boards), eight demonstration programs in the LISP and Pascal languages and ten subroutines written in assembly language that are callable from BASIC. In addition, there are over 50 source listings for programs and drivers. Also included are 80-odd library routines, callable by assembly-language programs (mostly having to do with I/O functions), a raft of programs for use with the DC Hayes modem board and assorted BASIC source listings.

The latest update for the system (version 4.3) came out in January 1980. The documentation for the update alone was about an inch thick . . . in addition to an enormous amount of previous material.

While some programs are trivial—a 160-byte program that sets or gives you the time of day and an 18-byte program that rings the bell on your terminal—and are not too difficult to write yourself, most of the programs are substantial:

BASIC language program—over 10,500 bytes, plus 10K for the compiler and 10K for the package that runs the compiled object code.

ISAM files—to create and maintain indexed sequential files, usable either with

BASIC or assembly-language programs.

EDIT—character-oriented editor that is similar to, although more comprehensive and easier to use than, the C/PN editor. I used this editor for creating my law-office system of programs and became quite familiar with its operation over a six-month period.

VUE—screen-oriented editor that will do more than EDIT and is faster and easier to use. VUE uses the cursor controls and simple 'CNTL-' combinations to accomplish its many functions. I have been using it extensively since its release last year and am totally sold on it. The biggest advantage is that text editing appears before you on the screen. To insert a line just hit CNTL-B and one will appear. Then type in the material you want there. You can either type over old text or toggle (with CNTL-Q) the insert mode; the old text will expand as you type in the new material or contract as you take out unwanted data. VUE even has some rudimentary text-formatting capability. There are over 50 functions.

TXTFMT—does extensive formatting of text: right margin justification, paragraphing, page length, title at top of each page if desired, page numbering top or bottom in a host of number types, vertical spacing, margin, sub-paragraph indentation and lettering. It will automatically create an index for you and output it at the end of your paper, if you wish. It will center text anywhere and print in boldface on command. I prepared this article with VUE and TXTFMT.

A macro assembler, a Dynamic Debugging Tool (DDT) program, Pascal and LISP are also supplied with the system.

Many of the programs supplied with the AM-100 system are used in the operation of the system itself. For example, LOG is used by the operator to get into a specific PPN and also performs other tasks; MEMORY allocates a block of memory for your use; ATTACH attaches your terminal to another job in the system; JOBPRI sets a priority for your job (i.e., a longer or shorter time-slice)

compared to other jobs; MOUNT tells the system that you have changed disks.

Another group of programs are system utilities, which are unnecessary for operation of the system, but they make it easier to use. There are two fast sort utilities—one for use in BASIC programs and one for general use. A flexible copy utility, which will copy one program, one group of programs or an entire disk, is provided. Other utilities provide for erasing programs from disk; changing passwords and PPNs; dumping files in ASCII, hex or octal from disks to your terminal; appending one program to the tail end of another; and listing the files and programs in your disk area (or others) on your terminal. There are scores of such programs.

There is also a line-printer spooler to make it easy to queue up programs or files for printing. The spooler runs in its own job, and so, printing a program listing or data file does not monopolize the computer's time—you start it going and proceed to other tasks.

### Command Language Processing

The AM-100 operating system supports a convenient and valuable tool called command language processing in which each entry from a terminal—when the system is in executive mode—is treated as a command by the system. A prompt character (period) indicates you are in this mode.

If you type DIR, the system will treat this as a command to look for a program of that name in the library section of the system's disk, load it into memory, execute it, output any information it has for you, delete it from memory and return you to executive mode. All this is done under program control.

Many commands require additional information. For instance, VUE requires the name of the program you wish to edit. LOG, if nothing else is given it, will tell you what disk area you are in; if a PPN follows the word LOG, you will be transferred to that PPN.



You can create a special file, called a command file, to take full advantage of command processing. A command file consists of a list of different commands you want executed. You call the file by typing its name. The system does the rest, executing each command, in order, until the file is exhausted.

For example, suppose you made a command file called BACKUP. (The actual name would be BACKUP.CMD. All programs and files have a six-letter (or less) name plus a three-letter extension. Often you can ignore the extension because the system recognizes "default" extensions. For example, the system will first look for a program called BACKUP. PRG (the extension for assembly-language object code modules). If the system can't locate this program, it will look for BACKUP.CMD, which it will load and run. On a two-terminal system with 20

disk, loads it and then executes it. Thus, no matter how complex your system is, no matter how many printers, disks or terminals it has, all you have to do to operate it is to hit the reset button. Full documentation on how to write SYSTEM.INI is provided by AlphaMicro, and your dealer will provide the initial program to get your system running.

Whenever you log into a new disk area (PPN), the LOG program will look for a special command file. If one is there, LOG will read it and execute whatever commands are in the file. Typically, this could be used to run a compiled BASIC program for a business user or for school students.

#### AlphaBasic

The AlphaMicro crew has improved upon the BASIC language by implementing the following features:

1. Variables may be designated with any

Whenever I want to read in a new client master record from the disk, the statement "READ #1, INREC" will access the entire record and read it into memory. (If I want to refer to any one of the 30-odd components of that record, I am free to do so.)

Memory mapping is unique to AlphaBasic and results in a language that is superior to any other BASIC in operation and programming. The departure from "standard" is well worth the extra flexibility of the language. Other uses for this feature will become apparent as you use it.

3. Labeled subroutines. This makes line numbers almost obsolete. If you have ever spent hours of frustrating debugging time over a long program, only to discover that the only problem is a call to a botched-up line number, you will appreciate this feature. Moreover, it makes BASIC programs more readable. Instead of a call to, say, line 2500, where a subroutine is to be found, you code it this way: CALL DOIT. Then label line 2500 like this: 2500 DOIT:. You are not limited to just subroutines; GOTOs are also valid when followed by a label. Essentially, the BASIC programmer is thus freed from keeping track of any line numbers. You can dispense with them entirely, in fact, by entering your BASIC program with the editor instead of the usual way. I haven't tried this yet; anyway, the compiler generates error messages referenced to line numbers.

Space simply does not permit a complete discussion of AlphaBasic, which includes features not found in any, or at least in few, other versions of BASIC. Bear in mind that the three unique features mentioned above are in addition to the many improvements in the original BASIC that have been made by others.

AlphaBasic may be used in an immediate mode, just like most of the other versions. Type "PRINT 2+2" (while in BASIC and without a line number), and the system will print a figure "4." It may be used in what we have come to think of as "normal," as in the interpreter versions (type in your program and say RUN; it will).

However, AlphaBasic is also a compiled language. You can compile the BASIC program and save the object code on disk. Thereafter, you needn't enter BASIC at all. Among other things, this means that you, or a command file, may run BASIC programs from executive mode. Furthermore, using the compiled code results in a great speed advantage. Also, the space occupied by the compiled program is far less than the source listing of BASIC statements. (For example, my Lawyer Billing source code is 30,720 bytes, while the compiled code is only 9202 bytes!) Compiled code permits you to market applications packages in BASIC, without revealing the source code. The system also permits you to compile saved BA-

| SYSJOB | ADAM   | 377,1 | P0 | BASIC | TI |
|--------|--------|-------|----|-------|----|
| SPOOL  | DUMMY  | 1,2   | P0 | LPTSP | EW |
| JOB1   | MALSER | 1,4   | P0 | DIR   | TO |
| JOB2   | MODEM  | 10,10 | P0 | LOG   | ^C |

Photo 3. DYSTAT display is on a monitor apart from any terminal and runs all the time. The display lists the jobs (column 1), the terminal (col. 2), disk area (col. 3), priority (col. 4), program (col. 5) and condition (col. 6).

megabytes of hard disk storage, the actual look-up time—from entry of a nonexistent program to error-message display—is less than 1.8 seconds; locating a command file takes less than .4 seconds.) In this file, store the commands that you would otherwise manually type in to make a backup of data files. As an added touch, use a few simple delimiters (;, < and >) on each side of any text you want to especially notice when you run the command file. While you're building this file, insert another delimiter (:K), which will stop the execution of the file until you hit return.

Now, all you have to do is type BACKUP, and the AM-100 system will automatically do all the rest—except physically load the disk into the driver. It will instruct you to do that and wait for you to hit return.

A command file called SYSTEM.INI is used to boot the system. This file contains the terminal definition blocks, definitions of the devices attached to the system, the line-printer-spooler parameters and other information essential to operate the system. The ROM-based bootstrap program, after start-up, looks for SYSTEM.INI on your system

length name. You are not limited to just a letter or two. For example, you can call a variable representing the customer's last name CUSTLN, and not just C\$ or CN\$. In fact, you could call it CUSTOMER'LAST' NAME if you had plenty of memory to spare for such nonsense and didn't mind typing that long, awkward form wherever it appeared in the program. All letters, not just the first two, are significant.

2. Memory mapping. For those of you who speak COBOL, this is similar to the data-formatting capabilities of that language. One difference is that, in COBOL, the variables must be defined in a separate section of the program, whereas in AlphaBasic, they may but need not be. You can use this feature in I/O techniques. For example, it is convenient to read many variables from a disk record (or write to disk) by using one key variable to refer to all the rest. In the programs I wrote for our law office, for instance, there are perhaps 30 variables in the client master record. I mapped these variables in AlphaBasic and refer to the whole group as INREC (Information RECORD).



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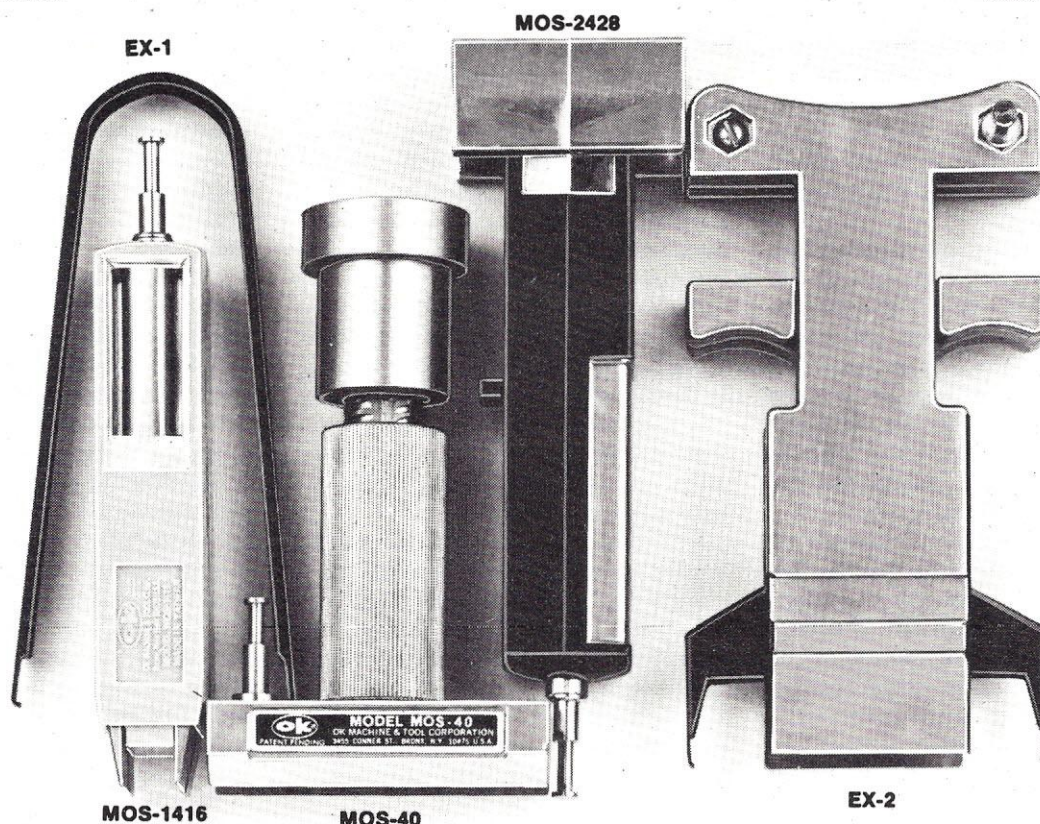


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SIC programs without entering BASIC. So, you don't have to worry about trying to retain sufficient memory for the compiled code while entering your source code.

### Critical Comments

One of the most troublesome problems was lack of documentation. The AM-100 is supported by a complex operating system that demands full explanation. The original documents concerning its use left a lot to be desired. There are still some deficiencies in this area; however, the last four releases (versions 4.0 to 4.3) of the system not only were well documented with regard to the new programs and latest changes, but also contained additional information on the use of the system's original features. In other words, AlphaMicro is doing something about this problem. As usual, they are doing it well. It just took a little while for them to get around to it!

There are still some bugs in the system. Most of them are minor. Known bugs are documented by AlphaMicro. That policy is a change from some software suppliers who treat the bugs in their programs as if they were holy: never to be discussed with the unwashed users. Furthermore, the AlphaMicro people want to hear about the bugs you find. They supply convenient forms to make it easy for you to report them.

The final problems concern memory. First—and this really is not criticism, but a fact of life—the system uses a lot of memory. Don't think you can buy an AM-100, put it in a box with 24K and then upgrade later. You can't, with any degree of satisfaction. Figure on filling the box with at least 64K.

Second, the system will not function with just any memory boards. This is without

question the most critical hardware requirement. I don't know the cause, but if your memory chips are the least bit flaky, you are going to have big problems. And, you can't use most dynamic memory boards at all. If you have any problems with the system, chances are they are caused by "bad" memory (which may function without hitch with another CPU board).

### Cost

No one ever said the AM-100 was cheap! The two CPU boards are \$1495, which includes the software license for the system software, but no disks with programs on them. The disks come with the disk controller board. But there's a catch-22. You can't use just any disk controller. Generally speaking, you will have to buy a controller (for floppies or hard disk) from AlphaMicro—even if you already have the drive itself—or the programs you are getting just won't work. This will mean, at a minimum, spending another \$695, for a total of \$2190.

This may seem like a lot, but if you calculate the total price of a CPU, hardware floating-point arithmetic board, disk controller, a quality operating system, an editor, assembler, word-processing package and miscellaneous utility software, you will come up with a surprising total... without the features of the AM-100!

Also consider that any business system is going to have disk drives, terminals and memory that total far more than \$2000. In other words, those CPU boards are not a large percentage of the total cost of a complete system.

The AM-100 is not inexpensive; however, for the price, you would be hard pressed to find a computer with as complex an operat-

ing system, a better language for business programs or the capacity to handle multiple terminals. Admitting I am prejudiced, but having spent months surveying the market before making a decision to buy, I think the AlphaMicro AM-100 is the best you can buy for less than \$40,000 or \$50,000. The AM-100, with everything you could hang on it, will cost about a third of that—lots less if you stay with floppy disks and shop around for a used line printer. (A hard disk and a new line printer can easily cost over \$8000.)

### Applications Software

AlphaMicro has a fine business accounting package for \$750. This price, considering the quality of the programs, is inexpensive, but it is also a bit misleading. You have to tailor the package to your own business. If you don't program in BASIC yourself, you will have to spend some bucks (maybe \$1000 or more) getting this work done for you.

There is a growing supply of other applications software designed for the AM-100. The AlphaMicro Users' Society (AMUS), based in Colorado, has a catalog of all the software presently available for the AM-100 from various suppliers.

Many AlphaMicro dealers have software of their own. The company picks its dealers with care. As a result, most are capable of generating not only good service and a friendly concern, but also good applications programs. My dealer (Data Domain in Bloomington, Indiana) not only helped me put together a workable system for my needs, but also assisted me in working out various problems I have had (most of which were the result of my own ignorance). This help was given freely, in spite of the fact

```
LOG
Current login is DSK0:[1,4]
LOG 10,10
Password:
Transferred from DSK0:[1,4] to DSK0:[10,10]

NOTE: GAMES ARE NOW IN AREA 101,10 ON DISK #1

BASIC
?Insufficient memory for Program load
?BASIC?
MEMORY
CURRENT MEMORY IS 5000 BYTES
MEMORY 0
MEMORY 20K
[20000 BYTES ASSIGNED]
BASIC
READY
```

```
BYE
.PRINT START.CMD
START.CMD
Total of 1 file (1 block) in Printer request
.DIR
START CMD 1 DSK0:[10,10]
LBF CMD 1
Total of 2 files in 2 blocks

.ERASE START.CMD
START.CMD
Total of 1 file deleted, 1 disk block freed
.PPN DSK0:
[1,2] [1,4] [1,6]
[2,2]
[7,0] [7,1] [7,4] [7,5] [7,6] [7,7]
[10,1] [10,2] [10,3] [10,10] [10,16] [10,101]
[11,1]
[101,2] [101,7] [101,17]
[377,5] [377,10]
LOG 1,4
Transferred from DSK0:[10,10] to DSK0:[1,4]
```

Photos 4 and 5. Operations frequently used with the AM-100. The system prompt symbol (period) indicates operator input; other lines were typed by the computer.



that I was writing all of my own applications programs. They did write a driver for my Malibu printer (not supported, yet, by Alpha-Micro) . . . at no charge, I might add.

Software for the IDS Modem-88, as well as other software, is available from Khalsa Computer Systems of Pasadena CA.

Dick Wilcox and the rest of the AlphaMicro crew have gone out of their way to ensure quality and competence on the part of their dealers, as well as with their system. This means that you, as an end user, can probably look to your dealer for whatever assistance you need in the way of applications programs. Contact me if you are interested in a Lawyer Billing File package—mostly for accounts receivable.

## Summary

The AM-100 system is truly a microcomputer system for the eighties. I doubt greatly that any company will equal this system, let alone surpass it, for many years to come. It is superior to many minicomputers that I have personally checked out—computers costing five to ten times as much. The manufacturer is AlphaMicro, 17881 Sky Park North, Irvine CA 92714.

I have an AM-100 system that has been operating for over a year, causing no trouble at all, doing what I want of it and making me money. What more can be said? ■

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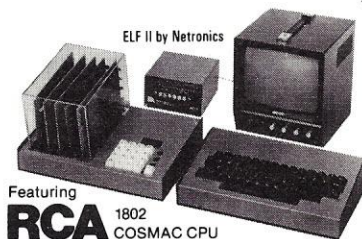
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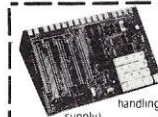
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Many programmers give up on writing in assembly language even though they know their programs would be faster and more powerful. To them assembly language seems difficult to understand and follow, as well as being a nightmare to debug. Well, not with proper tools like Debug I. With Debug I you can easily follow the flow of any Z80 or 8080 program. Trace the program one step at a time or 10 steps or whatever you like. At each step you will be able to see the instruction executed and what it did. If desired, modifications can then be made before continuing. It's all under your control. You can even skip displaying a subroutine call and up to seven breakpoints can be set during execution. Use of Debug I can pay for itself many times over by saving you valuable debugging time. \$79.95/\$20.

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This is an expanded debugger which has all of the features of Debug I plus many more. You can "trap" (i.e. trace a program until a set of register, flag, and/or memory conditions occur). Also, instructions may be entered and executed immediately. This makes it easy to learn new instructions by examining registers/memory before and after. And a RADIX function allows changing between ASCII, binary, decimal, hex, octal, signed decimal, or split octal. All these features and more add up to give you a very powerful development tool. Both Debug I and II must run on a Z80 but will debug both Z80 and 8080 code. \$99.95/\$20.

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## APPLE

8080 version of Zapple

## NEW! TPM now available for TRS-80 Model II!

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A NEW Z80 disk operation system! This is not CP/M\*. It's better! You can still run any program which runs with CP/M\* but unlike CP/M\* this operating system was written specifically for the Z80\* and takes full advantage of its extra powerful instruction set. In other words its not warmed over 8080 code! Available for TRS-80\* (Model I or II), Tarbell, Xitan DDDC, SD Sales "VERSAPLOPPY", North Star (SD&DD), and Digital (Micro) Systems. \$79.95/\$25.

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4. Name, Address and Phone number.
5. For TPM orders only: Indicate if for TRS 80, Tarbell, Xitan DDDC, SD Sales (5¼" or 8"). ICOM (5¼" or 8"), North Star (single or double density) or Digital (Micro) Systems.
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# Buy or Rent?

RUN

\*\*\*BUY OR RENT ? \*\*\*

ENTER PRICE OF HOUSE---\$ 41100

ENTER AMOUNT OF 'FRONT-MONEY' TO BE APPLIED TO  
PURCHASE.(TO PAY DOWN-PAYMENT AND CLOSING COSTS)---\$1650

ENTER ESTIMATED CLOSING COSTS (ATTORNEY'S FEE ,  
'POINTS',etc,---\$1650

ENTER EST. YEARLY PROP. TAXES AND INSURANCE---\$450

ENTER INTEREST RATE OF MORTGAGE---% 9.5

ENTER LENGTH OF MORTGAGE IN MONTHS 360

ENTER THE NUMBER OF MONTHS YOU WILL LIVE IN THE HOUSE/APT 39

ENTER YOUR ESTIMATED AVERAGE MARGINAL TAX RATE FOR  
THE PERIOD YOU WILL LIVE IN THE HOUSE/APT---%31

ENTER THE YEARLY APPRECIATION EXPECTED ON THE HOUSE---%9

WHEN YOU SELL, WILL YOU USE A REAL ESTATE AGENT? (Y OR N) Y

ENTER THE %-AGE OF THE CUSTOMARY AGENT'S COMMISSION---% 6

ENTER AMOUNT OF MONTHLY RENT---\$ 210

ENTER ESTIMATED YEARLY INCREASE IN RENT---% 6

ENTER THE BEST INVESTMENT INTEREST AVAILABLE TO YOU  
OVER THE LENGTH OF YOUR STAY (COMP.QTRLY)---% 6.5

IF YOU RENT WILL YOU INVEST THE DIFFERENCE BETWEEN THE MORTGAGE  
AND RENT PAYMENTS ? (Y OR N)Y

## COMPUTING

### \*\*\*BUYING INFO\*\*\*

|   |             |
|---|-------------|
| PRICE OF HOUSE                          | \$41,100.00 |
| 'FRONT-MONEY'                           | \$1,650.00  |
| CLOSING COSTS                           | \$1,650.00  |
| MONTHLY PROP. TAXES AND INSURANCE       | \$37.50     |
| AMOUNT OF MORTGAGE                      | \$41,100.00 |
| INTEREST RATE ON MORTGAGE               | 9.50 %      |
| MONTHLY PAYMENT (INCLUDES TAXES & INS.) | \$383.09    |
| ENTER 'A' FOR COST ANALYSIS.A           |             |

### \*\*\*COST ANALYSIS\*\*\*

|                               |                |
|-------------------------------|----------------|
| VALUE OF HOUSE AT END OF STAY | \$55,004.59    |
| MORTGAGE BAL. AT END OF STAY  | ( \$40,180.56) |
| AGENT'S COMMISSION            | ( \$3,300.28)  |
| NET PROCEEDS FROM SALE        | \$11,523.75    |

### \*\*\*\*\*

|                                   |                |
|-----------------------------------|----------------|
| LENGTH OF STAY                    | 39 MONTHS      |
| TOTAL OF PAYMENTS MADE            | \$16,590.55    |
| TAX SAVINGS FROM BUYING           | ( \$3,893.17)  |
| NET PROCEEDS FROM SALE            | ( \$11,523.75) |
| TOTAL COST OF BUYING              | \$1,173.63     |
| MONTHLY COST OF BUYING            | \$30.09        |
| ENTER 'R' TO DISPLAY RENTAL INFOR |                |

### \*\*\*RENTAL INFO\*\*\*

|  |            |
|--|------------|
| INITIAL MONTHLY RENT                     | \$210.00   |
| FINAL MONTHLY RENT                       | \$250.11   |
| TOTAL OF RENTAL PAYMENTS                 | \$8,773.01 |
| INTEREST ON 'FRONT-MONEY' SAVED          | \$126.84   |
| INTEREST ON MTG-RENT DIFFERENCE INVESTED | \$33.94    |
| NET COST OF RENTING                      | \$8,612.23 |
| MONTHLY COST OF RENTING                  | \$220.83   |
| REVIEW INFO ? (Y OR N)N                  |            |
| READY                                    |            |

Sample run 1.

RUN

\*\*\*BUY OR RENT ? \*\*\*

ENTER PRICE OF HOUSE---\$ 62000

ENTER AMOUNT OF 'FRONT-MONEY' TO BE APPLIED TO  
PURCHASE.(TO PAY DOWN-PAYMENT AND CLOSING COSTS)---\$14570

ENTER ESTIMATED CLOSING COSTS (ATTORNEY'S FEE ,  
'POINTS',etc,---\$2170

ENTER EST. YEARLY PROP. TAXES AND INSURANCE---\$820

ENTER INTEREST RATE OF MORTGAGE---% 10

ENTER LENGTH OF MORTGAGE IN MONTHS 360

ENTER THE NUMBER OF MONTHS YOU WILL LIVE IN THE HOUSE/APT 60

ENTER YOUR ESTIMATED AVERAGE MARGINAL TAX RATE FOR  
THE PERIOD YOU WILL LIVE IN THE HOUSE/APT---%38

ENTER THE YEARLY APPRECIATION EXPECTED ON THE HOUSE---%9

WHEN YOU SELL, WILL YOU USE A REAL ESTATE AGENT? (Y OR N) Y

ENTER THE %-AGE OF THE CUSTOMARY AGENT'S COMMISSION---% 6

ENTER AMOUNT OF MONTHLY RENT---\$ 300

ENTER ESTIMATED YEARLY INCREASE IN RENT---% 3

ENTER THE BEST INVESTMENT INTEREST AVAILABLE TO YOU  
OVER THE LENGTH OF YOUR STAY (COMP.QTRLY)---% 8

IF YOU RENT WILL YOU INVEST THE DIFFERENCE BETWEEN THE MORTGAGE  
AND RENT PAYMENTS ? (Y OR N)Y

## COMPUTING

### \*\*\*BUYING INFO\*\*\*

|   |             |
|---|-------------|
| PRICE OF HOUSE                          | \$62,000.00 |
| 'FRONT-MONEY'                           | \$14,570.00 |
| CLOSING COSTS                           | \$2,170.00  |
| MONTHLY PROP. TAXES AND INSURANCE       | \$68.33     |
| AMOUNT OF MORTGAGE                      | \$49,600.00 |
| INTEREST RATE ON MORTGAGE               | 10.00 %     |
| MONTHLY PAYMENT (INCLUDES TAXES & INS.) | \$503.61    |
| ENTER 'A' FOR COST ANALYSIS.A           |             |

### \*\*\*COST ANALYSIS\*\*\*

|                               |                |
|-------------------------------|----------------|
| VALUE OF HOUSE AT END OF STAY | \$97,072.22    |
| MORTGAGE BAL. AT END OF STAY  | ( \$47,900.81) |
| AGENT'S COMMISSION            | ( \$5,824.33)  |
| NET PROCEEDS FROM SALE        | \$43,347.08    |

### \*\*\*\*\*

|                                   |                |
|-----------------------------------|----------------|
| LENGTH OF STAY                    | 60 MONTHS      |
| TOTAL OF PAYMENTS MADE            | \$44,786.54    |
| TAX SAVINGS FROM BUYING           | ( \$9,278.60)  |
| NET PROCEEDS FROM SALE            | ( \$43,347.08) |
| TOTAL COST OF BUYING              | \$-7,839.15    |
| MONTHLY COST OF BUYING            | \$-130.65      |
| ENTER 'R' TO DISPLAY RENTAL INFOR |                |

### \*\*\*RENTAL INFO\*\*\*

|  |             |
|--|-------------|
| INITIAL MONTHLY RENT                     | \$300.00    |
| FINAL MONTHLY RENT                       | \$347.78    |
| TOTAL OF RENTAL PAYMENTS                 | \$19,112.89 |
| INTEREST ON 'FRONT-MONEY' SAVED          | \$1,417.16  |
| INTEREST ON MTG-RENT DIFFERENCE INVESTED | \$79.36     |
| NET COST OF RENTING                      | \$17,616.37 |
| MONTHLY COST OF RENTING                  | \$293.61    |
| REVIEW INFO ? (Y OR N)N                  |             |
| READY                                    |             |

Sample run 2.



Every year the addresses of 20 percent of the American population change. Many of these transients are corporate executives or mid- to upper-level government employees whose career patterns require frequent transfers. A move may be the result of a job change or promotion with an increase in earnings.

In any event, you probably have a friend who is deciding whether to enter the home-buying market—either for the first time or for a limited stay. This program will be helpful to such a decision-maker, while providing the computer hobbyist another answer to *the question*.

## The Program

The user first supplies information concerning the property he is considering buying, his tax rate, anticipated length of stay and return on investments. Rental data is also entered, and the user is asked whether, in the event he rents, he will invest the difference between his rent and what his house payment would have been.

It should be noted that the yearly appreciation on the house is compounded monthly. This was done so stays of less than twelve months could be evaluated.

The program was designed to help the newcomer to the housing market and does not take into account the recognition of gain to the taxpayer who sold a previous home at a profit and who does not reinvest in a house (Internal Revenue Code, sec. 1034). The user may wish to add a few lines to apply T1 (from line 150) to the amount of capital gain and add the result to the cost of renting.

In the printing of cost information, parentheses are used to identify amounts that are subtracted from an above unparenthesized amount in order to yield the amount appearing directly under the last parenthesized amount. Thus, in Sample run 1 under "Cost Analysis."

\$40,180.56 and \$3,300.28 are subtracted from \$55,004.59 to yield \$11,523.75.

Negative numbers are preceded by a minus sign as in the

“Cost of Buying” amounts in Sample run 2.

Sample run 1 illustrates a VA-  
"nothing down" loan, and Sample  
run 2 deals with a conven-

tional loan with a 20 percent down payment. In both runs the user-supplied input assumes a low property tax rate found in a rural area.

*Program listing.*

LIST

```

10 PRINT TAB(10);"***BUY OR RENT ? ***": PRINT : PRINT
20 REM--- PROGRAM BY ED PONS
30 INPUT "ENTER PRICE OF HOUSE---$ ",P1: PRINT
40 PRINT "ENTER AMOUNT OF 'FRONT-MONEY' TO BE APPLIED TO "
50 INPUT "PURCHASE,(TO PAY DOWN-PAYMENT AND CLOSING COSTS)---$",D1
60 PRINT
70 PRINT "ENTER ESTIMATED CLOSING COSTS (ATTORNEY'S FEE , "
80 INPUT "'POINTS',etc,---$",C1: PRINT
90 INPUT "ENTER EST. YEARLY PROP. TAXES AND INSURANCE---$",T5: PRINT
100 INPUT "ENTER INTEREST RATE OF MORTGAGE---% ",I1: PRINT
110 INPUT "ENTER LENGTH OF MORTGAGE IN MONTHS ",L1: PRINT
120 INPUT "ENTER THE NUMBER OF MONTHS YOU WILL LIVE IN THE HOUSE/APT ",S1
130 PRINT
140 PRINT "ENTER YOUR ESTIMATED AVERAGE MARGINAL TAX RATE FOR"
150 INPUT "THE PERIOD YOU WILL LIVE IN THE HOUSE/APT---%",T1
160 PRINT
170 INPUT "ENTER THE YEARLY APPRECIATION EXPECTED ON THE HOUSE---%",A1
180 PRINT
190 INPUT "WHEN YOU SELL,WILL YOU USE A REAL ESTATE AGENT? (Y OR N) ",Z%
200 PRINT
210 LET B1=0
220 IF Z%="N" THEN 250: IF Z%<>"Y" THEN 190
230 INPUT "ENTER THE %-AGE OF THE CUSTOMARY AGENT'S COMMISSION---% ",B1
240 PRINT
250 INPUT "ENTER AMOUNT OF MONTHLY RENT---$ ",R1: PRINT
260 INPUT "ENTER ESTIMATED YEARLY INCREASE IN RENT---% ",A2: PRINT
270 PRINT "ENTER THE BEST INVESTMENT INTEREST AVAILABLE TO YOU"
280 INPUT "OVER THE LENGTH OF YOUR STAY (COMP.QTRLY)---% ",I6: PRINT
290 PRINT "IF YOU RENT WILL YOU INVEST THE DIFFERENCE BETWEEN THE MORTGAGE"
300 INPUT "AND RENT PAYMENTS ? (Y OR N)",A# : PRINT
310 IF A#="N" THEN 330
320 IF A#<>"Y" THEN 290
330 PRINT : PRINT TAB(9);"&D&D&D&D&D&D COMPUTING &D&D&D&D&D&D&D"
340 PRINT : PRINT
350 REM- MORTGAGE CALCULATIONS
360 REM-AMT OF MTG
370 LET P2=P1+C1-D1
380 REM-AMT OF MONTHLY PMT (P3)
390 LET I2=I1/1200
400 LET P3=P2*(I2/(1-(1/(1+I2)^L1)))
410 LET T5=T5/12
420 REM-CALC. CUM AMT PAID(P4);MTG BAL(B2);CUM INT(I4);
430 REM- COST TO OWNER(C2);&TAX SAVINGS(P6)
440 LET P4=0: LET B2=P2: LET I4=0: LET C2=0
450 FOR K=1 TO S1
460 LET P4=P4+P3+T5
470 LET I3=B2*I2: LET I3=I3*100+.5: LET I3=INT(I3)/100
480 LET P5=P3-I3: LET B2=B2-P5: LET I4=I4+I3
490 LET C2=C2+P3+T5-I3*1/100
500 NEXT K
510 LET P6=P4-C2
520 REM-CALC RENT;CUM RENT(R2)
530 LET R2=0: LET R3=R1
540 FOR K=1 TO S1
550 LET R2=R2+R3
560 IF INT(K/12)=K/12 THEN GOSUB 590
570 NEXT K
580 GOTO 600
590 LET R3=R3*(1+A2/100): RETURN
600 REM-CALC INVESTMENT INTEREST(I5),(I9)
610 LET I6=I6/400: LET D2=D1: IF P3>R1 THEN LET D3=P3-R3
620 LET I5=0: LET I9=0
630 FOR J=1 TO S1
640 IF J/4<>INT(J/4) THEN 720
650 LET I7=I6*D2
660 LET I5=I5+I7
670 LET D2=D2+I7
680 IF A#<>"Y" THEN 720
690 LET I8=I6*D4
700 LET I9=I9+I8
710 LET D4=D4+I8+D3
720 IF J/12<>INT(J/12) THEN 770
730 REM-LESS TAX
740 LET T2=I5*T1/100: LET T3=I9*T1/100
750 LET I5=I5-T2: LET I9=I9-T3
760 LET D2=D2-T2: LET D4=D4-T3
770 NEXT J
780 REM-CALC.RENT NET COST(R4);NET MONTHLY COST(R5)
790 IF A#<>"Y" THEN LET I9=0
800 LET R4=R2-I5-I9: LET R5=R4/S1
810 REM-CALC FMV OF HOUSE
820 LET V1=P1: LET K=S1
830 FOR J=1 TO K
840 LET V1=V1*(1+A1/1200)
850 NEXT J
860 LET V2=V1-(V1*B1/100)
870 LET V2=V2-B2
880 LET V3=D1+C2-V2
890 LET V4=V3/S1
900 REM-INFO
910 LET P3=P3+T5
920 PRINT TAB(10);"***BUYING INFO***"

```



```

930 PRINT "PRICE OF HOUSE";TAB(40);%C11F2:P1
940 PRINT "'FRONT-MONEY';TAB(40);%C11F2:D1
950 PRINT "CLOSING COSTS";TAB(40);%C11F2:C1
960 PRINT "MONTHLY PROP. TAXES AND INSURANCE";TAB(40);%C11F2:T5
970 PRINT "AMOUNT OF MORTGAGE";TAB(40);%C11F2:P2
980 PRINT "INTEREST RATE ON MORTGAGE";TAB(40);%C11F2:I1;"%"
990 PRINT "MONTHLY PAYMENT (INCLUDES TAXES & INS.)";TAB(40);%C11F2:F3
1000 INPUT "ENTER 'A' FOR COST ANALYSIS.";A$: IF A$<>"A" THEN 1000
1010 PRINT TAB(10);"***COST ANALYSIS***"
1020 PRINT "VALUE OF HOUSE AT END OF STAY";TAB(40);%C11F2:V1
1030 PRINT "MORTGAGE BAL. AT END OF STAY";TAB(41);"(";%C11F2:B2;XD;")"
1040 PRINT "AGENT'S COMMISSION";TAB(41);"(";%C11F2:B1*V1/100;XD;")"
1050 PRINT "NET PROCEEDS FROM SALE";TAB(40);%C11F2:V2
1060 PRINT TAB(10);"*****"
1070 PRINT "LENGTH OF STAY";TAB(40);S1;" MONTHS"
1080 PRINT "TOTAL OF PAYMENTS MADE";TAB(40);%C11F2:P4+D1
1090 PRINT "TAX SAVINGS FROM BUYING";TAB(41);"(";%C11F2:P6;")"
1100 PRINT "NET PROCEEDS FROM SALE";TAB(41);"(";%C11F2:V2;")"
1110 PRINT "TOTAL COST OF BUYING";TAB(40);%C11F2:V3
1120 PRINT "MONTHLY COST OF BUYING";TAB(40);%C11F2:V4
1130 INPUT "ENTER 'R' TO DISPLAY RENTAL INFO";R$
1140 IF R$<>"R" THEN 1130
1150 PRINT TAB(10);"***RENTAL INFO***"
1160 PRINT "INITIAL MONTHLY RENT";TAB(40);%C11F2:R1
1170 PRINT "FINAL MONTHLY RENT";TAB(40);%C11F2:R3
1180 PRINT "TOTAL OF RENTAL PAYMENTS";TAB(40);%C11F2:R2
1190 PRINT "INTEREST ON 'FRONT-MONEY' SAVED";TAB(40);%C11F2:I5
1200 PRINT "INTEREST ON MTG-RENT DIFFERENCE INVESTED";TAB(40);%C11F2:I9
1210 PRINT "NET COST OF RENTING";TAB(40);%C11F2:R4
1220 PRINT "MONTHLY COST OF RENTING";TAB(40);%C11F2:R5
1225 INPUT "REVIEW INFO ? (Y OR N)";Y$
1227 IF Y$="Y" THEN 920
1230 END

```

## Adaptability Notes

The program is written in Processor Technology Extended Cassette BASIC but is easily adapted to any BASIC.

The &Ds in line 330 display control D, which with the SOL 20 is represented by a lightning bolt. The purpose of this line is to alert the non-computer-oriented user to the fact that the momentary pause is not due to his error (and so he won't bang on the side of your CRT to get the display going again!).

In line 930 and following, the %C11F2s are Processor Tech's formatting instructions, which cause the dollar signs, commas and proper number of decimal places to be inserted. ■

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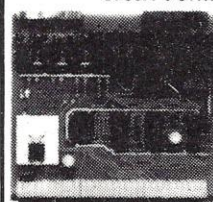
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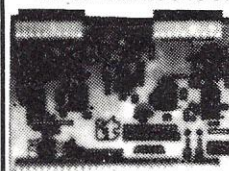
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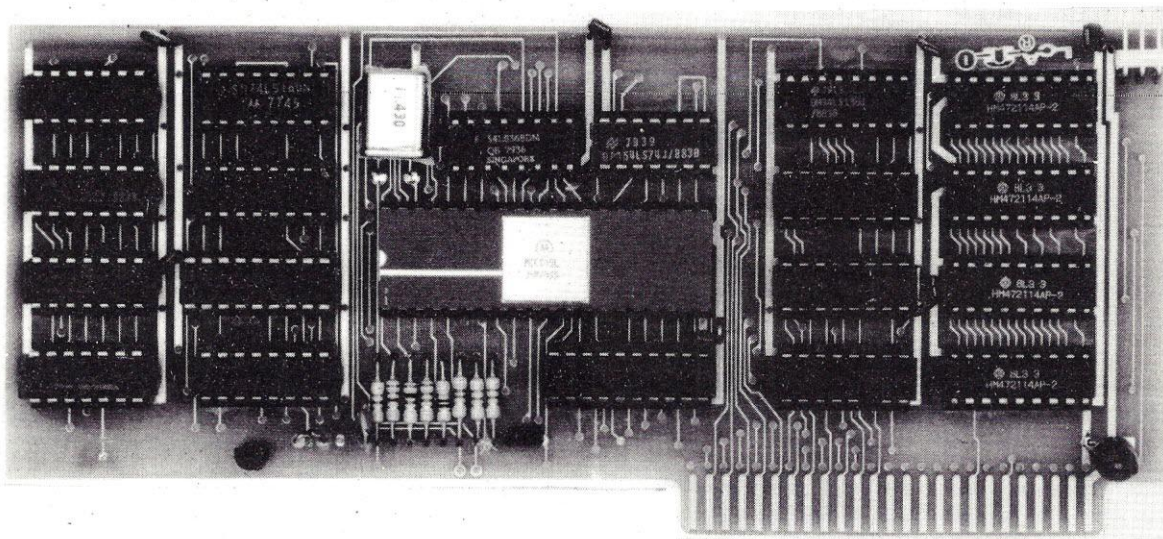
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# A COSMAC CDP1802, CDP1854 Monitor

*Communicate with the CDP1802 through a UART or an ACIA with this monitor.*

The monitor presented here has been written for a specific purpose. As such, it is only part of a larger program. How-

ever, I feel that it may be of sufficient interest for those who would like to communicate with their CDP1802 the way it

should be done, through a UART or an ACIA.

The CDP1854 is a particularly well-suited part for this purpose, since it has two modes, one of which (Mode 1) allows it to work together with the CDP1802 with a minimum of hardware and software. It is this mode in which it is employed.

## Hardware

The monitor, in its present form, occupies 565 ROM bytes. No attempt has been made to fit the program into 512 bytes only. One of the major advantages of the COSMAC system is that it requires a single voltage only, thus you would use a 2716/2516 ROM, or at least a 2758, with plenty of spare PROM locations for your own enhancements. If a TTL-level serial terminal is used, the need for any additional voltages will be eliminated.

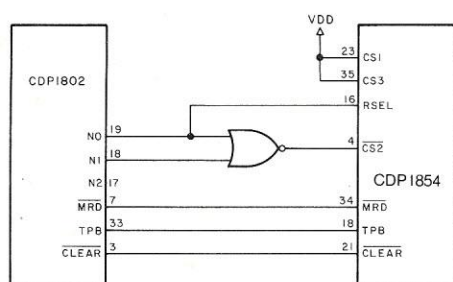
The monitor occupies low memory from 0000 up; RAM is required from FFFF down. With 256 RAM bytes, the system would be operational. For a minimum system, use of the highest address bit will suffice to discriminate between ROM and RAM.

The CPU communicates with the CDP1854 using the N-lines N0 and N1 and input/output commands 61, 62, 69 and 6A. Thus, the CDP1854 may be interfaced using only one additional two-input NOR gate or, if full N-line decoding is desired, a CDP1853. For both conditions, a diagram is given (see Fig. 1). A further diagram (Fig. 2) shows connections of all relevant lines to the CDP1854.

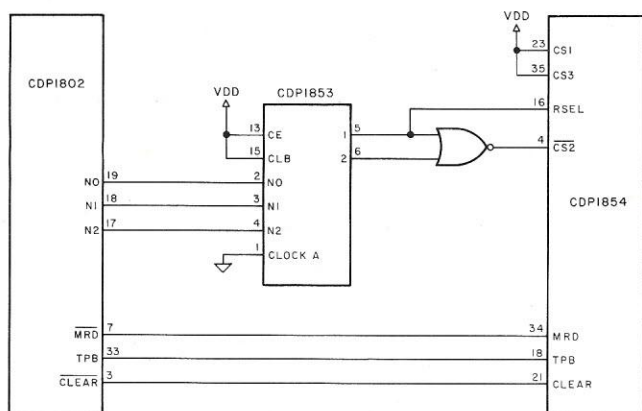
The CDP1854 is initialized to seven data bits, no parity and two stop bits, which may alternatively be regarded as seven data bits, parity = "Mark" and one stop bit (transmitting). For other configurations, consult Fig. 9 (Control Register Bit Assignment) of the RCA CDP1854D/CD data sheet. The UART control word is byte 0028 in the monitor.

## Firmware

The overriding requisite for this monitor has been the need for full, unlimited subroutine nesting ability. To accomplish this, I have used the SCRT programs found on pages 62 to 64 of the RCA User Manual for the CDP1802 COSMAC Microprocessor, Publication No. MPM-



A: USING N FLAGS ONLY



B: USING CDP-1853

Fig. 1. Principle of addressing CDP1854.



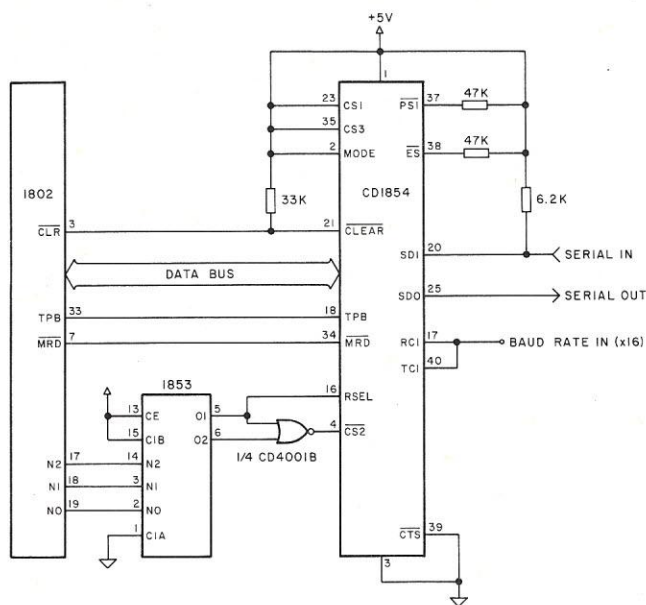


Fig. 2. Termination of all relevant pins of the CDP1854.

201B.

I made one small addition to the SCRT programs, which should also be made by every user routine engaging the X-register, namely, resetting X to point to RF and pointing RF to FFFF before exiting. In this monitor, X *always* points to RF, and RF *always* points to FFFF, restoring these conditions whenever they have been altered by the program.

This simplifies things considerably, inasmuch as you never have to ask, "Where does X point to now?" However, you may eventually come to your own conclusions concerning this matter.

R2 is the stack pointer and is initialized to point to FFEF. The top 16 locations of RAM are reserved for input-output and computed message strings (not presently employed by the monitor). Registers 1 and A are not yet utilized but are initialized to 0000, R1 by the program, RA by default, and may be employed by the user, as well as RB, RC and, for the most part, RD.

RE.1 is used as a shuttle to hand characters from one sub-routine to another and back.

The monitor contains a string-output routine (STOUT) to facilitate the transmission of ASCII strings of any length. Set RF to the head of string, make sure RX points to RF, then call

STOUT. STOUT will reset RF before exiting. The *last* character of every message must have a 1 in bit 7 to tell STOUT it is finished. STOUT may also be used to transmit single characters, such as in ALF, ASP and APR.

Please note that the 16 bytes of ATABL *must* be at the *head of a page* for the routines HEXIT and ASCIT to function.

#### EC-BUG HEX LIST:

```
> D 0000,0220
0000: F8 00 B1 F8 00 A1 F8 00 B4 F8 71 A4 F8 00 B5 F8
0010: 32 A5 F8 00 B7 F8 6A A7 F8 00 B6 A6 F8 FF BF AF
0020: F8 FF B2 F8 EF A2 EF F8 15 5F 61 2F F8 00 B3 F8
0030: 33 A3 D3 D4 00 BF D4 00 A7 D4 00 9B D4 00 8F 9E
0040: FB 41 C2 01 EF FB 05 C2 01 78 FB 01 C2 01 9F FB
0050: 03 C2 01 C4 FB 01 C2 01 DD FB 1F 32 64 FB 02 C2
0060: 08 00 30 3C D4 00 AB 30 18 D3 69 FE 3B 6A 30 69
0070: D3 E2 96 73 86 73 93 B6 83 A6 46 B3 46 A3 EF 30
0080: 70 D3 96 B3 86 A3 E2 12 72 A6 F0 B6 EF 30 81 69
0090: F6 3B 8F 6A BE D7 9E 5F 62 2F D5 F8 20 30 AD F8
00A0: 0A 30 AD F8 3A 30 AD F8 3E 30 AD F8 2A BE D4 00
00B0: 95 D5 0D BE D4 00 95 0D FE 33 BE 1D 30 B2 D5 F8
00C0: 00 BD F8 C7 AD 30 B2 0D 0A 7F 7F 7F FF D4 00 8F
00D0: D4 00 E5 9E FE FE FE FE FE D4 00 8F D4 00 E5 9E
00E0: 5F 8E F1 BE D5 F8 01 BF F8 00 AF 9E F3 32 F7 8F
00F0: FB 0F 32 18 1F 30 EB 8F BE F8 FF BF AF D5 C4 C4
0100: 30 31 32 33 34 35 36 37 38 39 41 42 43 44 45 46
0110: F8 01 BF 9E AF 0F BE F8 FF BF AF D5 9E AE F6 F6
0120: F6 F6 BE D4 01 10 D4 00 95 8E FA 0F BE D4 01 10
0130: D4 00 95 D5 D4 00 CD 9E BD D4 00 CD 9E AD D5 D4
0140: 01 34 9D B8 8D A8 D4 00 8F 9E FB 2C 3A 46 D4 01
0150: 34 9D B9 8D A9 D5 EF 99 5F 98 F3 3A 66 89 5F 88
0160: F3 3A 66 C0 00 18 D5 98 BE D4 01 1C 88 BE D4 01
0170: 1C D4 00 A3 D4 00 9B D5 D4 00 9B D4 01 3F D4 00
0180: 9F D4 00 BF D4 01 67 08 BE D4 01 1C D4 01 56 88
0190: FA 0F FB 0F 32 9C D4 00 9B 18 30 87 18 30 81 D4
01A0: 00 9B D4 01 34 9D B8 8D A8 D4 00 8F D4 01 67 D4
01B0: 00 CD 9E 58 D4 00 9B 88 FA 0F FB 0F 32 C1 18 30
01C0: AF 18 30 A9 D4 00 9B D4 01 3F D4 00 8F 9E FB 2C
01D0: 3A CA D4 00 CD 9E 58 D4 01 56 18 30 D5 D4 00 9B
01E0: D4 01 34 F8 01 B9 F8 EA A9 D9 9D B3 8D A3 D3 D4
01F0: 00 9B D4 01 34 9D B8 8D A8 D4 00 8F D4 00 9F D4
0200: 00 8F 9E FB 1B 32 0D 9E 58 18 C0 01 FF 28 08 F9
0210: 80 58 D4 00 8F D4 00 A3 D4 01 67 D4 00 9F C0 00
0220: 64
```

Hex listing of EC-Bug monitor (done on a TI terminal).

- G Go to an address and execute from there  
form: Gaaaa
- D Dump a range of memory  
form: Dssss,eeee
- E Enter hex bytes into successive memory locations from a  
given address  
form: E ssss (the space is automatically given)
- F Fill a range of memory with a given byte  
form: F ssss,eeee,bb
- A Enter a string of ASCII characters, including carriage  
return, line feed, bell and whatever is desired.  
form: A ssss

Note: Entering ASCII characters must be terminated by  
ESC, whereupon the monitor will print out the address  
location of the last character entered.

aaaa an address  
ssss a starting address  
eeee an end address (inclusive)  
bb a hex byte

In the "Enter" command, the input is terminated by entering  
any non-hexadecimal character.

In entering addresses, only the first four hex characters are  
seen by the monitor; the next character must be a comma.

Table 1. EC-Bug commands.

The assembly has been done  
on a somewhat primitive cross  
assembler. Please note that the  
asterisk signifies a high-order  
address byte. Calling a subrou-  
tine is therefore done as:

```
SEP R4
DB* LABEL
DB LABEL
```

#### Commands

In its present state, the moni-  
tor will allow four commands  
but is written so that more may  
easily be added. These com-  
mands are:

"D" = Dump, or display  
"E" = Enter HEX Bytes

#### EC-Bug monitor listing.

```
G100
COSMAC 1802 ASSEMBLER
SOURCE FILE? ECRUG.2000

SYMBOL TABLE
CWORD 0015
STAT 0001
CNTRL 0001
STACK FFEF
DATA 0002
RAM 0800
INTRR 0000
BEGIN 0000
```



|        |      |
|--------|------|
| CSTART | 0000 |
| WSTRT  | 001E |
| REPR   | 009F |

“F” = Fill Memory  
“G” = Go and execute  
Also See Table 1.

For some applications (for in-

stance, remote monitoring of soil moisture with solar cells as the only power source), C/MOS is the only choice. In addition, the C/MOS structure can inherently tolerate far greater temperature extremes than other

I hope that this brief presentation will win new friends for the COSMAC CDP1802, showing that it can do everything other processors can do and, almost as easily, some things even better. I also hope that

Once you can do unlimited subroutine nesting, you've got it made (or almost). ■

Sample run. EC-Bug commands.

|      |       |       |    |                       |
|------|-------|-------|----|-----------------------|
| 0000 | ORG   | 0     | 15 | #UART INITIALIZE      |
| 0000 | CWORD | EWU   | 1  | #UART STATUS          |
| 0000 | STAT  | EWU   | 1  | #UART CONTROL         |
| 0000 | CNTRL | EWU   | 2  | #STACK POINTER        |
| 0000 | STACK | EWU   | 0  | #DATA I/O             |
| 0000 | DATA  | EWU   |    |                       |
| 0000 | NAM   | EWU   |    |                       |
| 0000 | INTRR | INTR  |    | #INTERRUPT DUMMY      |
| 0000 | BEGIN | LDI*  |    | #INITIALIZE REGISTERS |
| 0000 | F800  | PHI   |    |                       |
| 0002 | B1    | R1    |    |                       |
| 0003 | F800  | INTRR |    |                       |
| 0005 | A1    | PLO   |    |                       |
| 0006 | F800  | LDI*  |    |                       |
| 0008 | B4    | CALL  |    |                       |
| 0009 | F871  | R4    |    |                       |
| 000B | A4    | CALL  |    |                       |
| 000C | F800  | R4    |    |                       |
| 000E | B5    | RETRN |    |                       |
| 000E | B5    | PHI   |    |                       |



```

000F F882      LDI      RETRN
0011 A5        PLO      R5
0012 F800      LDI*     LOOK
0014 B7        PHI      R7
0015 F86A      LDI      LOOK
0017 A7        PLO      R7
0018 F800      REST    LDI      00      ;DE-RANDOMIZE R6
001A B6        PHI      R6
001B A6        PLO      R6
001C F8FF      LDI      OFF
001E BF        PHI      RF
001F AF        PLO      RF
0020 F8FF      LDI*     STACK
0022 B2        PHI      R2
0023 F8EF      LDI      STACK
0025 A2        PLO      R2
0026 EF        SEX      RF

0027 F815      INIT    LDI      CWORD  ;INITIALIZE UART
0029 5F        STR      RF
002A 61        OUT      CNTRL
002B 2F        DEC      RF      ;RESTORE RF

002C F800      LDI*     PRMPT
002E B3        PHI      R3
002F F833      LDI      PRMPT
0031 A3        PLO      R3
0032 D3        SEP      R3

0033 D4        PRMPT   SEP      R4      ;DO A CR/LF
0034 00        DB*     DB*      CRLF
0035 BF        DB      DB*      CRLF
0036 D4        SEP      R4      ;PRINT PROMPT SIGN
0037 00        DB*     DB*      APR
0038 A7        DB      DB*      APR
0039 D4        SEP      R4      ;DO A SPACE
003A 00        DB*     DB*      ASP
003B 9B        DB      DB*      ASP

003C D4        CMDLP   SEP      R4      ;GET COMMAND
003D 00        DB*     DB*      INCH
003E BF        DB      DB*      INCH
003F 9E        GHI      RE      ;GET CHARACTER
0040 FB41      XRI      41      ;A?
0042 C201EF    LBZ      STENT
0045 FB05      XRI      05      ;D?
0047 C20178    LBZ      DUMP
004A FB01      XRI      01      ;E?
004C C2019F    LBZ      ENTER
004F FB03      XRI      03      ;F?
0051 C201C4    LBZ      FILL
0054 FB01      XRI      01      ;G?
0056 C201DD    LBZ      GOTO
0059 FB1F      XRI      1F      ;X?
005B 3264      BZ       STAR
005D FB02      XRI      02      ;Z?
005F C20800    LBZ      RAM
0062 303C      BR       CMDLP

0064 D4        STAR    SEP      R4      ;PRINT STAR TO INDICATE
0065 00        DB*     DB*      AST      ;BREAKOUT (ILLEGAL ENTRY)
0066 AB        DB      DB*      AST
0067 3018      BR       REST

;LOOK SCANS THRE OF UART

0069 D3        GO      SEP      R3
006A 69        LOOK    INP      STAT
006B FE        SHL      ;EMPTY?
006C 3B6A      BNF      LOOK    ;LOOP, IF NOT EMPTY
006E 3069      BR       GO

;STANDART CALL AND RETURN ROUTINES

0070 D3        EXITA   SEP      R3      ;RETURN
0071 E2        CALL    SEX      R2
0072 96        GHI      R6
0073 73        STXD

```

```

0074 86        GLO      R6
0075 73        STXD
0076 93        GHI      R3
0077 B6        PHI      R6
0078 83        GLO      R3
0079 A6        PLO      R6
007A 46        LDA      R6
007B B3        PHI      R3
007C 46        LDA      R6
007D A3        PLO      R3
007E EF        SEX      RF
007F 3070      BR       EXITA

0081 D3        EXITR   SEP      R3
0082 96        RETRN   GHI      R6
0083 83        PHI      R3
0084 86        GLO      R6
0085 A3        PLO      R3
0086 E2        SEX      R2
0087 12        INC      R2
0088 72        LDXA
0089 A6        PLO      R6
008A F0        LDX
008B B6        PHI      R6
008C EF        SEX      RF
008D 3081      BR       EXITR

008F 69        INCH    INP      STAT    ;WAIT FOR TERMINAL ENTRY
0090 F6        SHR
0091 3B8F      BNF      INCH    ;LOOP UNTIL ENTRY
0093 6A        INP      DATA    ;CHAR. ARRIVED
0094 BE        PHI      RE      ;STORE IT FOR CALLING ROUTINE

0095 D7        OUTCH   SEP      R7      ;CALL LOOK
0096 9E        GHI      RE      ;GET CHARACTER
0097 5F        STR      RF
0098 62        OUT      DATA    ;ECHO IF IT WAS INPUT
0099 2F        DEC      RF      ;RESTORE RF
009A D5        SEP      R5      ;RETURN

009B F820      ASP     LDI      20      ;PRINTS A SPACE
009D 30AD      BR       ONEC
009F F80A      ALF     LDI      0A      ;PRINTS A LINE FEED
00A1 30AD      BR       ONEC
00A3 F83A      ACL     LDI      3A      ;PRINTS A COLON
00A5 30AD      BR       ONEC
00A7 F83E      APR     LDI      3E      ;PRINTS A PROMPT SIGN
00A9 30AD      BR       ONEC
00AB F82A      AST     LDI      2A      ;PRINTS A STAR
00AD BE        PHI      RE
00AE D4        SEP      R4
00AF 00        DB*     OUTCH
00B0 95        DB      OUTCH
00B1 D5        SEP      R5      ;RETURN

;STOUT STRING OUTPUT ROUTINE
;EXPECTS RD TO POINT TO TOP OF
;STRING. LAST CHARACTER IN STRING
;MUST HAVE BIT 7=1.

00B2 0D        STOUT   LDN      RD      ;GET CHARACTER
00B3 BE        PHI      RE      ;PUT INTO SHUTTLE
00B4 D4        SEP      R4      ;GO TO PRINT IT
00B5 00        DB*     OUTCH
00B6 95        DB      OUTCH
00B7 0D        LDN      RD      ;GET CHARACTER AGAIN
00B8 FE        SHL      ;BIT 7=1?
00B9 33BE      BDF      FINIS    ;IF YES, RETURN
00BB 1D        INC      RD      ;ADVANCE POINTER
00BC 30B2      BR       STOUT    ;DO NEXT CHARACTER
00BE D5        FINIS   SEP      R5      ;RETURN

;CRLF DOES CARRIAGE RETURN, LINE FEED
;AND NULLS FOR DELAY

00BF F800      CRLF    LDI*     CLN
00C1 BD        PHI      RD      ;SET RD TO
                                ;HEAD OF TABLE

```



```

00C2 F8C7      LDI      CLN
00C4 AD        PLO      RD
00C5 30B2      BR       STOUT

00C7 0D        CLN      DB      0D      ;CR
00C8 0A        DB      0A      ;LF
00C9 7F        DB      7F      ;DEL
00CA 7F        DB      7F      ;DEL
00CB 7F        DB      7F      ;DEL
00CC FF        DB      0FF     ;DEL, END OF STRING

;BIN, A SUBROUTINE TO ENTER TWO HEX-CHARACTERS
;AND ASSEMBLE THEM INTO A BYTE

00CD D4        BIN      SEP      R4      ;GET FIRST CHARACTER
00CE 00        DB*      INCH
00CF 8F        DB      INCH
00D0 D4        SEP      R4      ;GO TO CONVERT IT
00D1 00        DB*      HEXIT
00D2 E5        DB      HEXIT
00D3 9E        GHI      RE      ;GET HEX NIBL
00D4 FE        SHL      ;SHIFT IT TO HIGH NIBL
00D5 FE        SHL
00D6 FE        SHL
00D7 FE        SHL
00D8 AE        PLO      RE      ;SAVE IT FOR NOW
00D9 D4        SEP      R4      ;GET SECOND CHARACTER
00DA 00        DB*      INCH
00DB 8F        DB      INCH
00DC D4        SEP      R4      ;CONVERT IT
00DD 00        DB*      HEXIT
00DE E5        DB      HEXIT
00DF 9E        GHI      RE      ;GET LOW NIBL
00E0 5F        STR      RF      ;STORE IT FOR ORING
00E1 8E        GLO      RE      ;RECALL HIGH NIBL
00E2 F1        OR       ;OR IT TO LOW NIBL
00E3 BE        PHI      RE      ;LEAVE IT FOR CALLING ROUTINE
00E4 D5        SEP      R5      ;RETURN

00E5 F801      HEXIT    LDI*     ATABL    ;SET RF TO POINT TO TABLE
00E7 BF        PHI      RF
00E8 F800      LDI      ATABL
00EA AF        PLO      RF
00EB 9E        MHEX     GHI      RE      ;GET CHARACTER
00EC F3        XOR      ;COMPARE
00ED 32F7      BZ       GOT      ;EXIT, IF MATCH FOUND
00EF 8F        GLO      RF      ;GET LOW ADDRESS
00F0 FB0F      XRI      0F      ;COMPARE FOR END OF TABLE
00F2 3218      BZ       REST     ;OUT, IF NO MATCH FOUND
00F4 1F        INC      RF      ;ADVANCE POINTER
00F5 30EB      BR       MHEX     ;DO NEXT COMPARISON
00F7 8F        GLO      RF      ;GET LOW ADDRESS
00F8 BE        PHI      RE      ;PUT IT INTO SHUTTLE
00F9 FBFF      LDI      0FF     ;RESTORE RF
00FB BF        PHI      RF
00FC AF        PLO      RF
00FD D5        SEP      R5      ;RETURN

00FE C4        NOP
00FF C4        NOP

0100 30        ATABL    DB      30
0101 31        DB      31
0102 32        DB      32
0103 33        DB      33
0104 34        DB      34
0105 35        DB      35
0106 36        DB      36
0107 37        DB      37
0108 38        DB      38
0109 39        DB      39
010A 41        DB      41
010B 42        DB      42
010C 43        DB      43
010D 44        DB      44
010E 45        DB      45

```

```

010F 46        DB      46

;ASCIT SUBROUTINE TO RECEIVE A HEX NIBL
; IN RE.1, CONVERT IT INTO AN ASCII-CHARACTER,
; AND RETURN IT TO CALLING ROUTINE IN RE.1

0110 F801      ASCIT    LDI*     ATABL    ;SET RF TO POINT
0112 BF        PHI      RF      ;TO ASCII CHARACTER
0113 9E        GHI      RE
0114 AF        PLO      RF
0115 0F        LDN      RF      ;GET CHARACTER OPPOSITE ADDRESS
0116 BE        PHI      RE
0117 FBFF      LDI      0FF     ;RESTORE RF
0119 BF        PHI      RF
011A AF        PLO      RF
011B D5        SEP      R5      ;RETURN

;BOUT SUBROUTINE TO PRINT A BYTE
; RECEIVED IN RE.1

011C 9E        BOUT     GHI      RE      ;GET BYTE
011D AE        PLO      RE      ;SAVE IT FOR LOWER NIBL
011E F6        SHR
011F F6        SHR
0120 F6        SHR
0121 F6        SHR
0122 BE        PHI      RE
0123 D4        SEP      R4      ;CONVERT IT
0124 01        DB*      ASCIT
0125 10        DB      ASCIT
0126 D4        SEP      R4      ;ASCII IS IN RE.1!
0127 00        DB*      OUTCH
0128 95        DB      OUTCH
0129 BE        GLO      RE      ;PROCESS NOW LOWER NIBL
012A FA0F      ANI      0F      ;MASK OUT UPPER NIBL
012C BE        PHI      RE
012D D4        SEP      R4
012E 01        DB*      ASCIT
012F 10        DB      ASCIT
0130 D4        SEP      R4
0131 00        DB*      OUTCH
0132 95        DB      OUTCH
0133 D5        SEP      R5

;ADIN ASSEMBLES AN ADDRESS AND LEAVES IT IN RD

0134 D4        ADIN     SEP      R4      ;GET HIGH BYTE OF ADDRESS
0135 00        DB*      BIN
0136 CD        DB      BIN
0137 9E        GHI      RE      ;BYTE IS IN RE.1
0138 BD        PHI      RD      ;MAKE IT HIGH ADDRESS BYTE
0139 D4        SEP      R4      ;GET LOW BYTE OF ADDRESS
013A 00        DB*      BIN
013B CD        DB      BIN
013C 9E        GHI      RE
013D AD        PLO      RD      ;MAKE IT LOW BYTE OF ADDRESS
013E D5        SEP      R5      ;RETURN

;DADD GETS A DOUBLE ADDRESS, LEAVES HIGH ADDRESS IN R8
; AND LEAVES LOW ADDRESS IN R9

013F D4        DADD     SEP      R4      ;GET FIRST ADDRESS
0140 01        DB*      ADIN
0141 34        DB      ADIN
0142 9D        GHI      RD      ;PUT INTO R8
0143 B8        PHI      R8
0144 BD        GLO      RD
0145 A8        PLO      R8
0146 D4        NOC      SEP      R4      ;GET A COMMA
0147 00        DB*      INCH
0148 BF        DB      INCH
0149 9E        GHI      RE      ;WAS IT A COMMA?
014A FB2C      XRI      2C
014C 3A46      BNZ      NOC      ;IF NOT TRY AGAIN
014E D4        SEP      R4      ;GET SECOND ADDRESS
014F 01        DB*      ADIN

```



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```

0150 34      DB      ADIN
0151 9D      GHI     RD      #PUT IT INTO R9
0152 B9      PHI     R9
0153 8D      GLO     RD
0154 A9      PLO     R9
0155 D5      SEP     R5      #RETURN

```

```

;COMPA  COMPARES THE ADDRESS IN R8 TO THE
;        ADDRESS IN R9. JUMPS TO REST
;        IF MATCH IS FOUND.

```

```

0156 EF      COMPA   SEX     RF
0157 99      GHI     R9
0158 5F      STR     RF
0159 98      GHI     R8
015A F3      XOR     NYET    #COMPARE HIGH BYTES
015B 3A66    BNZ
015D B9      GLO     R9
015E 5F      STR     RF
015F 88      GLO     R8
0160 F3      XOR     NYET    #COMPARE LOW BYTES
0161 3A66    BNZ
0163 C00018  LBR     REST
0166 D5      NYET    SEP     R5      #RETURN

```

```

;OUTA   PRINTS THE ADDRESS IN R8

```

```

0167 98      OUTA   GHI     R8      #GET HIGH BYTE OF ADDRESS
0168 BE      PHI     RE      #PUT IT INTO SHUTTLE
0169 D4      SEP     R4      #PRINT IT
016A 01      DB*    BOUT
016B 1C      DB     BOUT
016C 88      GLO     R8      #GET LOW BYTE OF ADDRESS
016D BE      PHI     RE      #E.T.C.
016E D4      SEP     R4
016F 01      DB*    BOUT
0170 1C      DB     BOUT
0171 D4      SEP     R4      #PRINT A COLON
0172 00      DB*    ACL
0173 A3      DB     ACL
0174 D4      SEP     R4      #PRINT A SPACE
0175 00      DB*    ASP
0176 9B      DB     ASP
0177 D5      SEP     R5      #RETURN

```

```

;DUMP   DUMPS BYTES FROM A STARTING ADDRESS
;        TO AN END ADDRESS

```

```

0178 D4      DUMP   SEP     R4      #DO A SPACE
0179 00      DB*    ASP
017A 9B      DB     ASP
017B D4      SEP     R4      #GET ADDRESSES
017C 01      DB*    DADD
017D 3F      DB     DADD
017E D4      SEP     R4      #DO A LINE FEED
017F 00      DB*    ALF      #FOR CLARITY
0180 9F      DB     ALF
0181 D4      STLN   SEP     R4      #START THE LINE
0182 00      DB*    CRLF
0183 BF      DB     CRLF
0184 D4      SEP     R4      #PRINT THE ADDRESS
0185 01      DB*    OUTA
0186 67      DB     OUTA
0187 08      ANUB   LDN     R8      #LOAD THE BYTE
0188 BE      PHI     RE      #PUT IT INTO SHUTTLE
0189 D4      SEP     R4      #PRINT IT
018A 01      DB*    BOUT
018B 1C      DB     BOUT
018C D4      SEP     R4      #COMPARE FOR LAST ADDRESS
018D 01      DB*    COMPA
018E 56      DB     COMPA

```

```

018F 88      GLO     R8      #COMPARE FOR END OF LINE
0190 FA0F    ANI     OF
0192 FB0F    XRI     OF
0194 329C    BZ      PFNL    #IF NOT END, NEXT BYTE OUT
0196 D4      SEP     R4      #PRINT A SPACE
0197 00      DB*    ASP
0198 9B      DB     ASP
0199 18      INC     R8      #ADVANCE POINTER
019A 3087    BR      ANUB
019C 18      PFNL   INC     R8
019D 3081    BR      STLN

```

```

;ENTER  LOADS HEX BYTES INTO SUCCESSIVE MEMORY LOCATIONS
;        FROM A STARTING ADDRESS. RETURNS UPON ENTRY
;        OF ANY ILLEGAL CHARACTER

```

```

019F D4      ENTER  SEP     R4      #DO A SPACE FOR CLARITY
01A0 00      DB*    ASP
01A1 9B      DB     ASP
01A2 D4      SEP     R4      #GET THE ADDRESS
01A3 01      DB*    ADIN
01A4 3A      DB     ADIN
01A5 9D      GHI     RD
01A6 B8      PHI     R8
01A7 8D      GLO     RD
01A8 AB      PLO     R8
01A9 D4      NULIN  SEP     R4      #DO CR/LF
01AA 00      DB*    CRLF
01AB BF      DB     CRLF
01AC D4      SEP     R4      #PRINT THE ADDRESS
01AD 01      DB*    OUTA
01AE 67      DB     OUTA
01AF D4      NUBYT  SEP     R4      #GET BYTE
01B0 00      DB*    BIN
01B1 CD      DB     BIN
01B2 9E      GHI     RE      #BYTE IS IN RE.1
01B3 58      STR     R8      #DEPOSIT
01B4 D4      SEP     R4      #PRINT A SPACE
01B5 00      DB*    ASP
01B6 9B      DB     ASP
01B7 88      GLO     R8      #CHECK FOR END OF LINE
01B8 FA0F    ANI     OF
01BA FB0F    XRI     OF
01BC 32C1    BZ      PRNL
01BE 18      INC     R8      #ADVANCE POINTER
01BF 30AF    BR      NUBYT
01C1 18      PRNL  INC     R8
01C2 30A9    BR      NULIN

```

```

;FILL   FILLS A DEFINED RANGE OF MEMORY
;        WITH THE SAME BYTE

```

```

01C4 D4      FILL   SEP     R4      #DO A SPACE
01C5 00      DB*    ASP
01C6 9B      DB     ASP
01C7 D4      SEP     R4      #GET ADDRESS RANGE
01C8 01      DB*    DADD
01C9 3F      DB     DADD
01CA D4      GCOM   SEP     R4      #GET A COMMA
01CB 00      DB*    INCH
01CC 8F      DB     INCH
01CD 9E      GHI     RE      #GET CHARACTER
01CE FB2C    XRI     2C      #WAS IT A COMMA
01D0 3ACA    BNZ     GCOM    #IF NOT, TRY AGAIN
01D2 D4      SEP     R4      #GET FILL BYTE
01D3 00      DB*    BIN
01D4 CD      DB     BIN
01D5 9E      FMOR   GHI     RE
01D6 58      STR     R8      #STORE IT TO RAM
01D7 D4      SEP     R4      #COMPARE FOR ADDRESS LIMIT
01D8 01      DB*    COMPA
01D9 56      DB     COMPA
01DA 18      INC     R8      #ADVANCE POINTER
01DB 30D5    BR      FMOR

```



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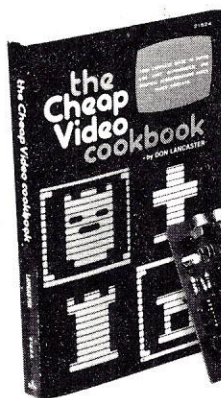
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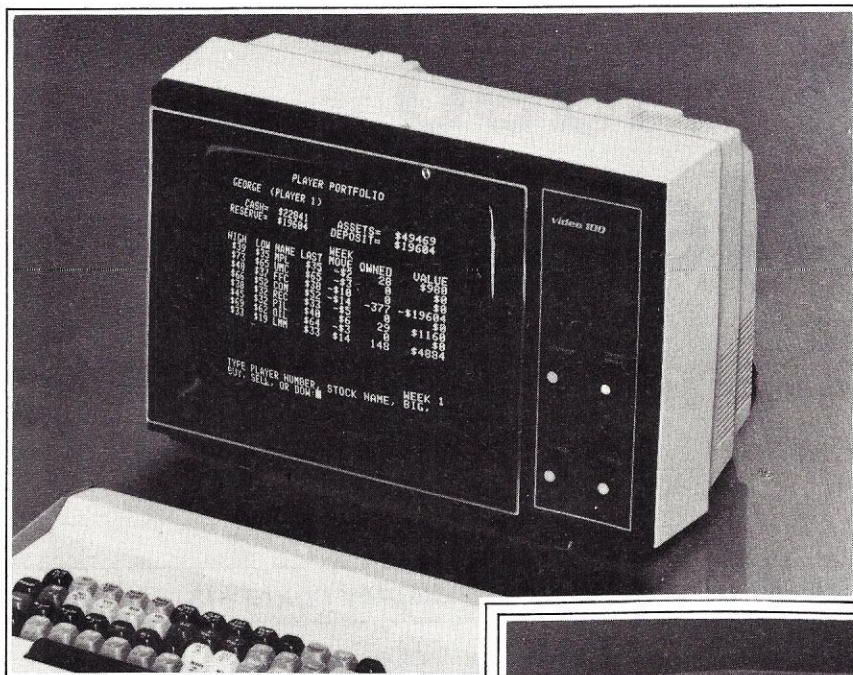
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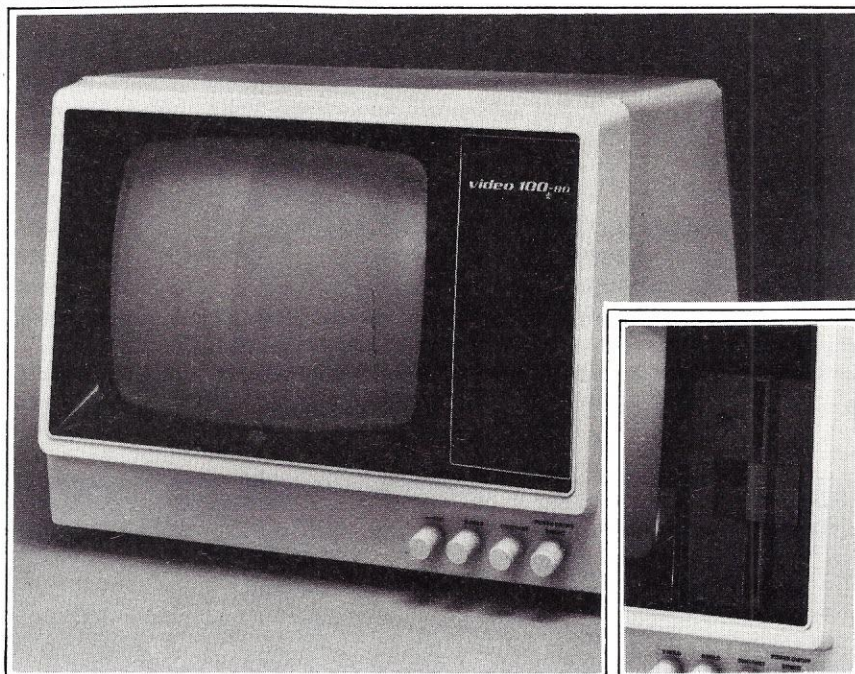
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most ASCII-encoded keyboards. I have satisfactorily mated my video board with a Radio Shack project board keyboard.

The Netronics product has many features that belie its modest \$89.95 (kit without keyboard) price tag:

- F-8 microprocessor controlled with crystal oscillator
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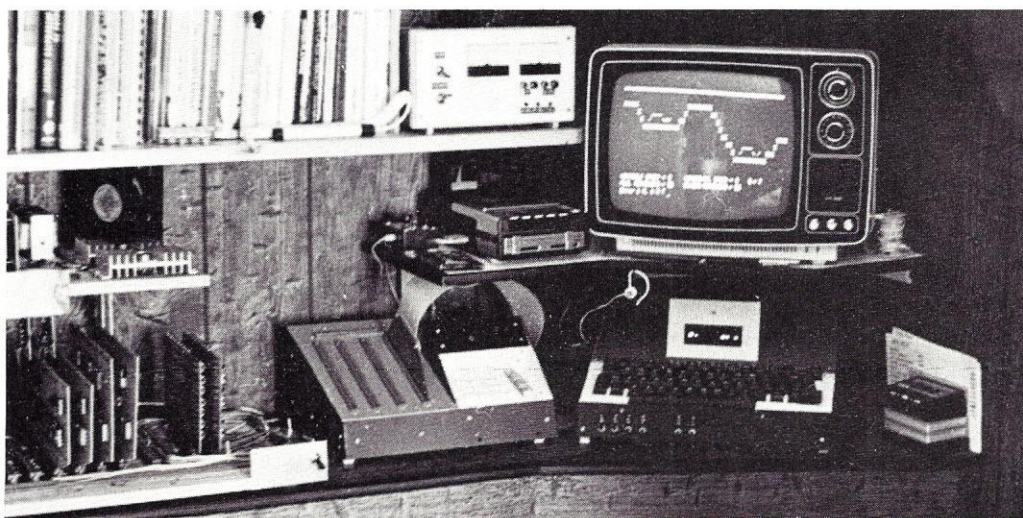
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- ASCII mode absolute and relative cursor addressing
- Device control by means of the DC3 control character
- Five-level mode control characters: carriage return (CR), line feed (LF), letters (LETS) and figures (FIGS)

The printed circuit card is high-quality glass epoxy with plated-through holes. There are no handling difficulties with the integrated circuits, most of which are 74 LS series. The video display board is designed to interface with any computer using an RS-232-C or 20 mA serial port. With a modem, it could be used as a telephone terminal.

The assembly manual includes the patches necessary to use the video board with the Netronics version of 1802 Tiny BASIC. The modifications to the software make available to the Elf II user an extra 1000 or so



Overall view of my 1802 system. At left are memory and the associated power supply; in the center is the CPU unit; at right are the ASCII keyboard and monitor. The Netronics video board is mounted beneath the keyboard.  
(Photos by James Lucas)



bytes of memory space. The improvement in the video display over the character generator of Tiny BASIC is striking. The display is more professional in appearance, and program readouts are much easier to design. Although Tiny BASIC's PLOT command no longer functions (the 1861 video chip is not used after the program modifications), the absolute and relative cursor sequence can be used to program a substitute plot function.

## Assembly

The kit is not difficult to assemble, but kit-building experience is helpful. Included with the kit are sockets for the F-8 and the character generator IC. I used sockets for all ICs to facilitate troubleshooting and repair.

The kit includes an on-board 5 V regulator. A filtered power supply is required to power the video board. If you select the RS-232-C output option, a negative supply will also be needed. The  $\pm 8$  V supply (see Fig. 1) will satisfy both needs.

Connection to the video board from an encoded ASCII keyboard is accomplished at location J-2. A 14-pin socket is provided for plug-in convenience. The Netronics keyboard connects directly to this J-2 socket. To interface to other keyboards, see Table 1 for the pin-out at J-2. Note that the strobe (or data ready) line at pin 6 can be either active low or active high.

Netronics recommends the RS-232-C output option for the Elf, so that is the one I chose. Output hookup to the Giant Board's serial port, including Giant Board jumper requirements, is covered in the assembly manual. You should ignore conflicting statements in the Giant Board manual, as the Tiny BASIC modifications correct for the differences. As modified, Tiny will communicate both with the hex keypad and the video board. You should test the assembled video board according to the manual's instructions before connecting it to your Elf. You can then patch Tiny and test the Elf and display together. This way, you will know whether a problem is in the display hard-

| ASCII parallel output | Video board J-2 pin-out |
|-----------------------|-------------------------|
| D <sub>0</sub>        | 11                      |
| D <sub>1</sub>        | 4                       |
| D <sub>2</sub>        | 12                      |
| D <sub>3</sub>        | 3                       |
| D <sub>4</sub>        | 13                      |
| D <sub>5</sub>        | 2                       |
| D <sub>6</sub>        | 14                      |
| Strobe/<br>data ready | 6                       |

(ASCII D<sub>7</sub> is ignored)

Table 1. Video board J-2 pin-out.

ware or an incorrect patch.

## Operation

While Tiny BASIC is operating, nothing will happen on the screen that does not come from the Elf. Whatever is typed on the ASCII keyboard is echoed by Tiny for display on the screen. The changes in Tiny BASIC alter some of the program's running characteristics. Print statements can no longer be frozen by depressing the input switch on the hex keypad. Breaks in program execution can still be produced by depressing an ASCII keyboard key, but a more reliable break occurs when input is used. With the 1861 chip disabled, programs run a little faster.

A substitute plot function can be programmed using the cursor sequence as described in the manual. There is also a downshift sequence allowing display of special print characters. These are mostly mathematics symbols and portions of the Greek alphabet.

## User Comment

My setup uses a portable television set with rf modulator. Netronics recommends selecting the 32-character line with

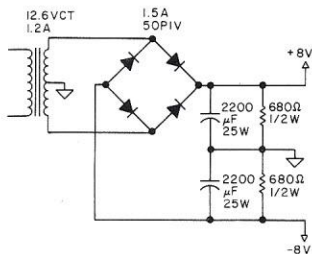


Fig. 1.  $\pm 8$  volt filtered power supply.

| ASCII | decimal | hex | H  | V  | ASCII | decimal | hex | H  | V  |
|-------|---------|-----|----|----|-------|---------|-----|----|----|
| .     | 96      | 60  | 32 | 0  | @     | 64      | 40  | 0  | 0  |
| a     | 97      | 61  | 33 | 1  | A     | 65      | 41  | 1  | 1  |
| b     | 98      | 62  | 34 | 2  | B     | 66      | 42  | 2  | 2  |
| c     | 99      | 63  | 35 | 3  | C     | 67      | 43  | 3  | 3  |
| d     | 100     | 64  | 36 | 4  | D     | 68      | 44  | 4  | 4  |
| e     | 101     | 65  | 37 | 5  | E     | 69      | 45  | 5  | 5  |
| f     | 102     | 66  | 38 | 6  | F     | 70      | 46  | 6  | 6  |
| g     | 103     | 67  | 39 | 7  | G     | 71      | 47  | 7  | 7  |
| h     | 104     | 68  | 40 | 8  | H     | 72      | 48  | 8  | 8  |
| i     | 105     | 69  | 41 | 9  | I     | 73      | 49  | 9  | 9  |
| j     | 106     | 6A  | 42 | 10 | J     | 74      | 4A  | 10 | 10 |
| k     | 107     | 6B  | 43 | 11 | K     | 75      | 4B  | 11 | 11 |
| l     | 108     | 6C  | 44 | 12 | L     | 76      | 4C  | 12 | 12 |
| m     | 109     | 6D  | 45 | 13 | M     | 77      | 4D  | 13 | 13 |
| n     | 110     | 6E  | 46 | 14 | N     | 78      | 4E  | 14 | 14 |
| o     | 111     | 6F  | 47 | 15 | O     | 79      | 4F  | 15 | 15 |
| p     | 112     | 70  | 48 | 0  | P     | 80      | 50  | 16 | 0  |
| q     | 113     | 71  | 49 | 1  | Q     | 81      | 51  | 17 | 1  |
| r     | 114     | 72  | 50 | 2  | R     | 82      | 52  | 18 | 2  |
| s     | 115     | 73  | 51 | 3  | S     | 83      | 53  | 19 | 3  |
| t     | 116     | 74  | 52 | 4  | T     | 84      | 54  | 20 | 4  |
| u     | 117     | 75  | 53 | 5  | U     | 85      | 55  | 21 | 5  |
| v     | 118     | 76  | 54 | 6  | V     | 86      | 56  | 22 | 6  |
| w     | 119     | 77  | 55 | 7  | W     | 87      | 57  | 23 | 7  |
| x     | 120     | 78  | 56 | 8  | X     | 88      | 58  | 24 | 8  |
| y     | 121     | 79  | 57 | 9  | Y     | 89      | 59  | 25 | 9  |
| z     | 122     | 7A  | 58 | 10 | Z     | 90      | 5A  | 26 | 10 |
| {     | 123     | 7B  | 59 | 11 | [     | 91      | 5B  | 27 | 11 |
| :     | 124     | 7C  | 60 | 12 | \     | 92      | 5C  | 28 | 12 |
| }     | 125     | 7D  | 61 | 13 | ]     | 93      | 5D  | 29 | 13 |
| ~     | 126     | 7E  | 62 | 14 | >     | 62      | 3E  | 30 | 14 |
| ?     | 63      | 3F  | 63 | 15 | *     | 95      | 5F  | 31 | 15 |

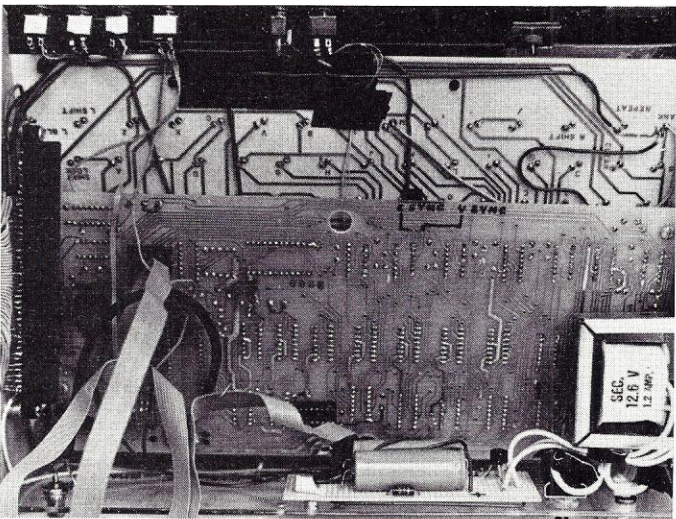
\* Substitutions

Table 2. ASCII characters as cursor addresses.

this arrangement. With my TV-1 modulator, the 32-character display line is excellent. My preference is for the 64-character line, which is still quite readable. The higher density line is better for programs using graphic displays.

Video board operation differs from that described in the assembly manual. The manual states that characters in a print

statement are lost after a form feed (FF). I did not find this to be so; nothing is lost. The manual also says up to 48 characters are lost after an end of line (EOL) erase at 300 baud. In fact, 50 characters are lost for a full line erase. Proportionately less is lost for less than a full line erase, and the loss at 110 baud is also proportionately less. The end of screen erase (EOS) works



Video board close-up. At bottom right is the recommended power supply of Fig. 1. The connector at left is for the Netronics Giant Board I/O module, to which the video board connects.



```

0010 GO TO 50
0011 PR "DS A"
0012 RETURN
0050 ....

```

(Do not insert any spaces into the program)

Listing 1. Downshift delete print subroutine.

as described in the manual.

Several Tiny BASIC peculiarities also cause the video display to work unexpectedly. Tiny filters out 13, 00, 0A and 7F hex characters in the input line buffers. This means that nulls (00) cannot be used as fillers for the erase functions. Use 01 hex (SOH, start of heading) or any other non-printable, non-cursor control character as filler instead.

You also cannot use delete (DEL), 7F hex, in a cursor sequence or a downshift special character print sequence. A question mark (?), hex 3F, can be substituted in the cursor sequence. If your Tiny uses hex 5E (†) as the line cancel code, it

can't be used in a cursor sequence; use >, hex 3E, instead (see Table 2). Hex 5E is not used in any downshift print sequence.

This still leaves you without the ability to print the special delete print character... except by trickery. While Tiny will not accept and store in program memory 7F hex, you can use a POKE statement to do the same thing. However, you must know at what address to poke 7F. Tiny BASIC, as modified for video board use, begins user programs at 0B87 hex, 2951.

Line 10 in Listing 1 sends the program to line 50, where the normal beginning of the program occurs. Lines 11 and 12 contain a subroutine that can be

called from anywhere in the program. The reason for putting the subroutine so close to the beginning is to make it easier to determine where to poke 7F.

Table 3 shows a hex memory dump of Listing 1. You can see that the technique is to type the Listing 1 program, using A as a filler, and then to POKE location 0B96 hex, 2966, with 7F hex, 127. The POKE command can be part of the main program or executed directly.

You now have a subroutine to print the special downshift delete character. The extra effort is necessary because this character is useful in creating graphics. You can also use this technique if your program needs to print 0A hex (line feed) or 13 hex (device control 3).

Using the video board poses three disadvantages. First, there is no built-in graphics capability as with some other computer systems. Second, if you list a program containing cursor moves, the list may write over itself with the cursor obeying the

programmed commands. Third, the cursor addressing method is rigid and inconvenient as designed. This is because the data used to move the cursor is the hex code of characters (evaluated modulo 16 for vertical and modulo 64 for horizontal) rather than the value of variables. The result is that one program line is needed for each possible cursor move. Unfortunately, relative and absolute addressing both work in the same way.

While I have no suggestions to offer concerning the first two disadvantages, you can overcome the third disadvantage with a bit of trickery once again. You can use the same trick you used with the downshift sequence (see Table 4).

As before, the normal beginning of the program is at line 50. The subroutine of lines 11 and 12 can be called from anywhere in the program. Poke location 0B96 hex, 2966, with = or + for absolute or relative addressing, respectively. The hex character for = is 3D; 2B for +. Poke loca-

#### Program listing

```

0010 GO TO 50
0011 PR "ESC A A ";
0012 RETURN
0050 ....

```

#### Address

Hex Decimal  
0B87 2951  
0B90 2960

#### Memory (hex)

|    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|
| 00 | 0A | 47 | 4F | 54 | 4F | 35 | 30 | 0D |
| 00 | 0B | 50 | 52 | 22 | 1B | 41 | 41 | 41 |
| 22 | 3B | 0D |    |    |    |    |    |    |
| 00 | 0C | 52 | 45 | 54 | 55 | 52 | 4E | 0D |

(Do not insert any spaces into this program)

Table 4. Cursor address program.

#### Address

| Hex  | Decimal | Memory (hex)               |
|------|---------|----------------------------|
| 0B87 | 2951    | 00 0A 47 4F 54 4F 35 30 0D |
| 0B90 | 2960    | 00 0B 50 52 22 10 41 22 0D |
|      |         | 00 0C 52 45 54 55 52 4E 0D |

Table 3. Hex memory dump of Listing 1.

Do you need instructions (Y or N) ?

Klaybor is a poisoned planet in a far away galaxy. Its atmosphere is deadly, so life is confined to the domed over cities. The people of Klaybor depend on the radiation shield to protect them from the emissions of a nearby star. You are a shuttle pilot. Your job is to get your ship (+) from one city to the other. Enter vertical thrust: + for up, - for down. Enter horizontal thrust: + for right, - for left. Klaybor's G force is 7 units. Your vertical landing speed cannot be greater than -1 unit. You must land precisely in the landing bay and the bay doors must close before your oxygen runs out. There is NO room for error. OK (Y or N) ?

```

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
X          X          X          X          X          X          X          X
X /  \  X /  \  X /  \  X /  \  X /  \  X /  \  X /  \  X /  \  X /  \  X
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0
X          X          X          X          X          X          X          X
X /  \  X /  \  X /  \  X /  \  X /  \  X /  \  X /  \  X /  \  X /  \  X
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
VERTICLE SPEED = 0    HORIZONTAL SPEED = 0    G = 7
FUEL REMAINING = 55  OXYGEN REMAINING = 80
Enter : V, : H ?

```

Examples of the kind of display obtainable using the 64-character format and an rf modulator. Netronics suggests the 32-character format with rf modulators. I had to adjust TV-1's channel and video level pots and the television's fine-tuning, brightness and contrast controls to get a readable 64-character display.



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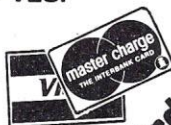
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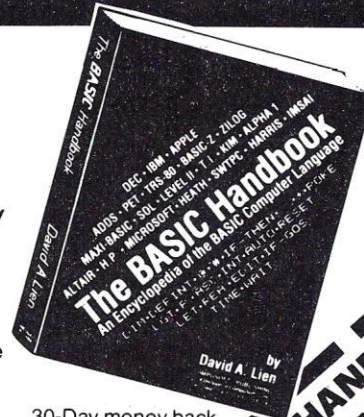
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| Horizontal            |         |
|-----------------------|---------|
| 0 1 2 3 4 5 . . . . . | 63      |
| 0 x                   |         |
| V 1                   |         |
| e 2                   |         |
| r 3                   |         |
| t 4                   |         |
| i 5 y                 |         |
| c                     |         |
| a                     |         |
| l                     |         |
| Examples:             |         |
| Position              | Address |
| x (upper left)        | = 0,0   |
| y                     | = 5,0   |
| 15 z (lower right)    | = 15,63 |

**Table 5. Cursor address screen layout.**

tion 0B97 hex, 2967, with the desired value for the vertical address component, which can be the value of a variable. Poke location 0B98 hex, 2968, with the horizontal address component, which can also be the value of a variable. The vertical address component is evaluated modulo 16, while the horizontal component is evaluated modulo 64.

Refer to Table 5 for the layout of the screen according to the vertical and horizontal addresses used. This subroutine/poke technique is flexible enough to use the ASCII characters as discussed in the assembly manual. Table 2 shows the equivalent of each ASCII character used as vertical and horizontal addresses. This figure includes the substitutions discussed earlier, even though they are not required when a POKE is used. Note that any values between 0 and 255, except 13 (0D hex), can be poked. Tiny would read the 0D as a carriage return and terminate the line. A program error would result.

The print and cursor subroutines can be used together with an adjustment in program line numbers and poke addresses used.

I have two suggestions:

Install a double-pole, double-throw switch as shown in Fig. 2 between the video board and Giant Board. Thrown one way, the switch permits normal operation between the display and

your Elf. Thrown the other way, Elf II is cut off from the type on the ASCII keyboard. The video board echoes to itself, so the type still shows up on the screen. This means you can, for example, clear the screen by typing form feed (FF) without fouling up your next input or program line to Tiny BASIC.

Keep your keyboard's parallel output connected to the parallel port on the Giant Board. That way, you still have use of the INP(7) function.

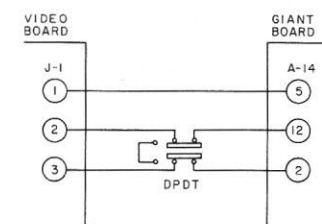
## Summary

Netronic's video board is a good value for the money. I especially recommend it for Elf II users. It will make you feel more like you have a "real" computer setup.

Some of the problems associated with the video board can be overcome as I have suggested. Others are either insignificant or the result of Tiny BASIC quirks, which will probably disappear once a full BASIC is released. Netronics states that their full BASIC will require the video board.

As with Tiny BASIC, use of the video board will reduce the amount of memory that might otherwise be required. Netronic's full BASIC will execute out of 8K of memory, whereas Quest's full BASIC needs a little over 11K of memory. This is another good reason to consider adding the video board to your Elf.

I have written some Tiny BASIC programs (for example, a real-time lander with textual display and a flight program with a graphics display) that demonstrate the operation of the cursor address sequence. Any interested readers can send me a stamped, self-addressed envelope for more information. ■



**Fig. 2. Terminal isolating switch wiring.**



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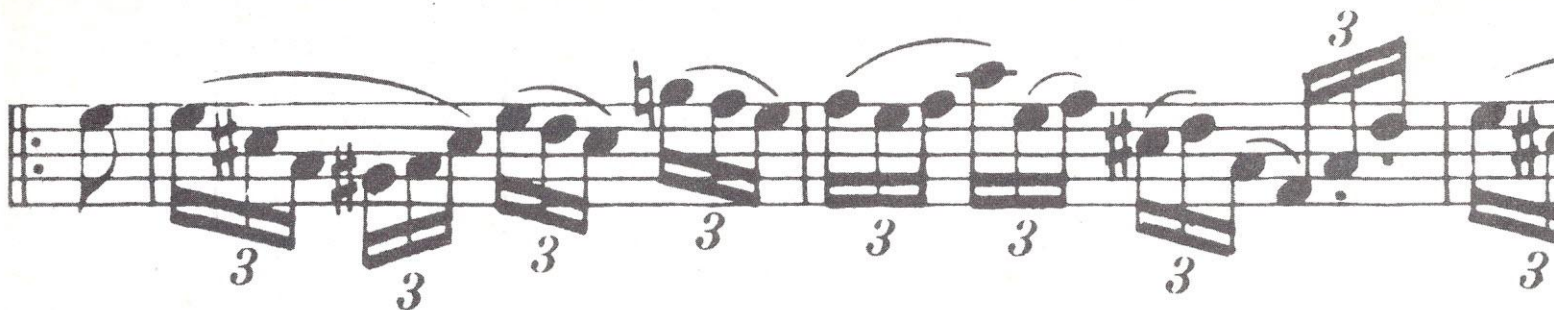
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# JazZ-80



*Requiring an inexpensive S-100 microcomputer to control an eight-voice music board, this constructor/conductor used the Z-80 Starter System to build his music generator.*

Cary N. Davids  
6000 Puffer Rd.  
Downers Grove IL 60515

I needed an inexpensive S-100 microcomputer to control an eight-voice music board that I designed and built. I arrange music for a 17-piece jazz band, and occasionally I need to check the flow of harmonies in short passages scored for many

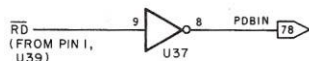


Fig. 1. Simple circuit, using existing unused inverter, which produces S-100 signal PDBIN.

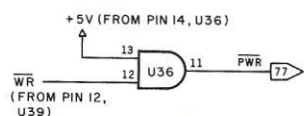


Fig. 2. Simple circuit, using existing spare AND gate, which produces S-100 signal PWR.

instruments. Since it is impractical to assemble an orchestra just for this purpose, I decided to construct a computer-controlled music generator that would enable me to hear the harmonies as I wrote them.

My requirements for the computer included: machine-language programming capability, display, keyboard, cassette interface, 2 MHz clock rate and system monitor in ROM. I was prepared to add sufficient memory and a real-time clock for my application, and I preferred to purchase the computer in kit form. After searching the ads in the major microcomputer magazines, I realized that I could assemble such a system, but it would cost more than \$1000.

Not wanting to spend that much money, I let things slide until my local computer store owner showed me the SD Systems Z-80 Starter System, which is a single-board computer with a hexadecimal keyboard and six-digit display. I had originally wanted an ASCII keyboard and a video display, but after reading the Starter System brochure, I became less concerned with these features.

## Hardware

The Z-80 Starter System is a complete (except for power supply) Z-80 microcomputer on a 12 inch x 12 inch board. It has an onboard keyboard and a six-digit display, 300 baud Kansas City cassette interface, wire-wrap area and a 5 V 2716/2758 PROM

programmer. The system includes 1K bytes of static RAM, expandable to 2K on the board, a 2K ROM monitor and a four-channel counter-timer (Z-80-CTC). The kit version which I purchased also came with the Z-80-PIO chip, which provides two parallel I/O ports.

The heavy-grade circuit board has a silk-screened parts legend and is solder masked on both sides. Address, data and control signals from the Z-80 CPU, as well as the outputs from the Z-80-CTC and Z-80-PIO, are conveniently available at the wire-wrap area. Two 24-pin sockets are provided for PROMs, one of which is also used for programming. Documentation includes a 114-page operations manual and the 30-page *Mostek Z-80 Micro-Reference Manual*. Sockets for all ICs are provided.

The feature that finally sold me, however, was the expansion area set aside for two S-100 connectors. At the kit price of \$249 (\$399, assembled and tested), it appeared to fulfill all my requirements.

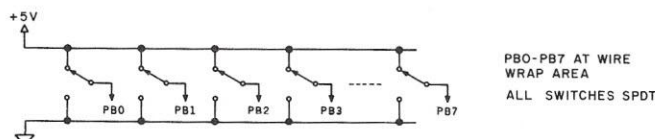


Fig. 3. Schematic of sense switch panel, interfaced to Z-80 Starter System via Z-80-PIO I/O port B.



## Assembly

After unpacking all the parts and checking them off on the parts list, I began assembly. It begins with the installation of the 15 support legs, followed by the IC sockets. I recommend doing the resistors before the sockets, since they are the smallest. In this way, the resistors will be held in place properly for soldering when the board is turned over.

A careful assembly job pays off, since most Starter Kits returned to the factory suffer from soldering errors made during assembly. I put mine together in about 4 hours, with the worst part being the search for a place to put capacitor C2, which, it turned out, is an extra.

After carefully checking for solder bridges, I applied power with no ICs present (smoke test). A single +5 V dc regulated power supply capable of supplying 1 Amp is required. (A separate +25 V 30 mA supply is needed for PROM programming.)

When purchasing or building a power supply, you should keep in mind the expansion capabilities of the Z-80 Starter System and make provision for the voltages needed by S-100 boards, namely, unregulated +8 V and  $\pm 16$  V dc. Such power supplies are available for minimal investment from manufacturers advertising in the microcomputer magazines.

The appearance of the "prompt" character on the display when all ICs were plugged in and the power turned on signaled that all was OK. See Photo 1 for a view of the completed kit.

## Firmware

Programming the Z-80 Starter System is done using the hexadecimal keyboard and display, along with the 2K monitor program ZBUG in ROM. Commands available in ZBUG allow the programmer to examine and change data in memory, I/O ports and 21 of the 22 CPU registers.

For debugging programs there is a single-step key, and up to five breakpoints can be inserted in a program. With the latter two capabilities, you can

return control to the monitor program after executing one or more user program instructions, allowing inspection of memory, port and register contents. After the program has been debugged, it can be saved and retrieved using the cassette dump and load commands. An LED lights up when loading data from tape, making program storage on an inexpensive cassette recorder convenient and reliable.

## Programming

The Z-80 CPU instruction set consists of all the 8080A instructions, plus 80 additional instructions specific to the Z-80. An important feature implemented by these new instructions and the

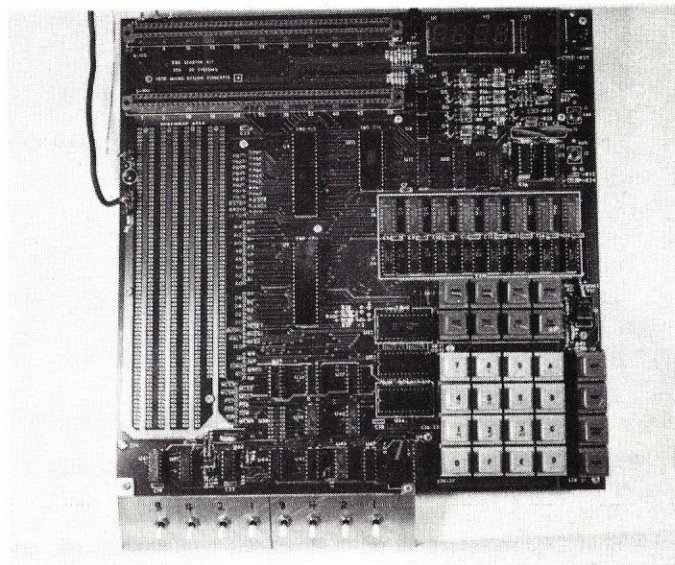


Photo 1. The completed Z-80 Starter System, including sense switches.

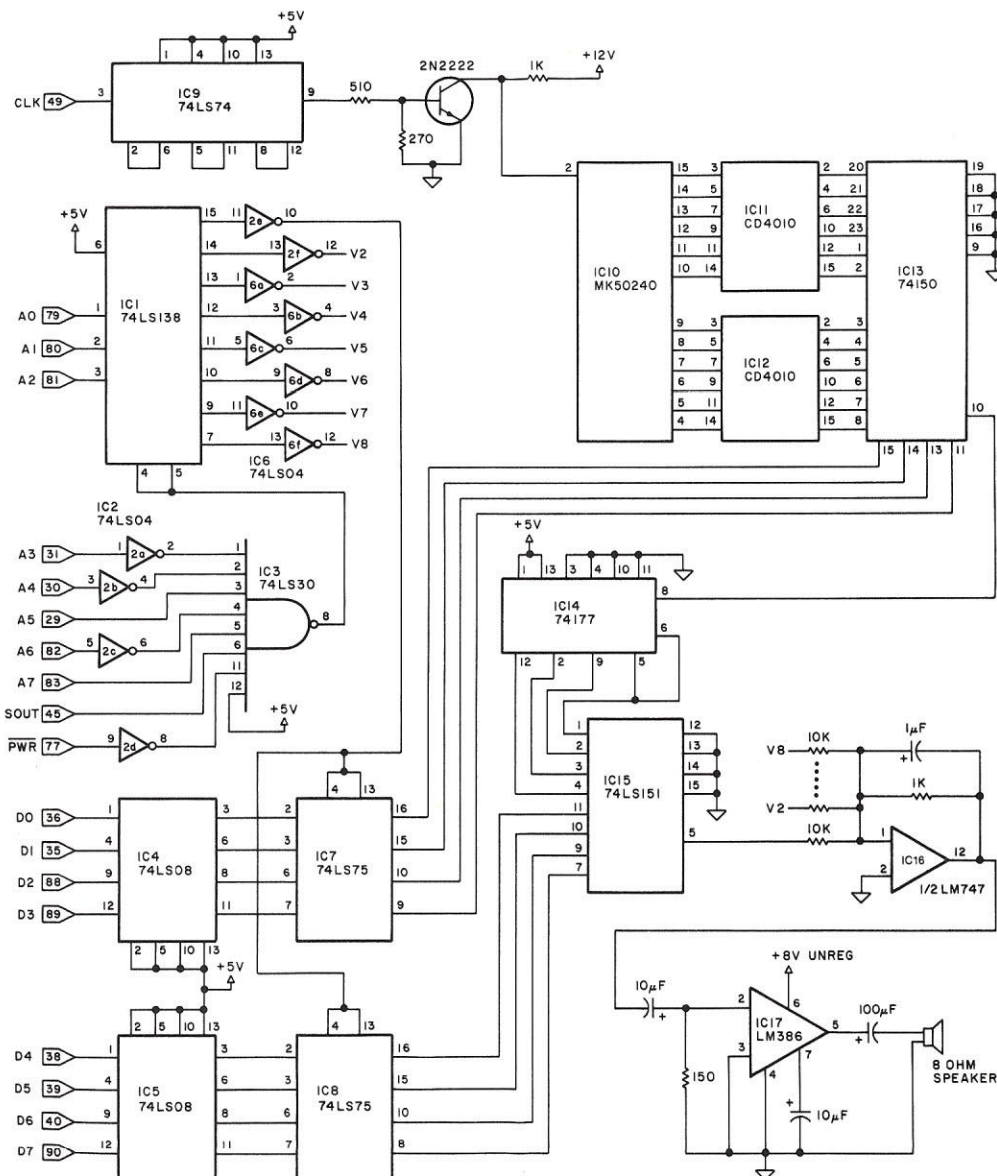


Fig. 4. Schematic of one voice and common control circuitry of eight-voice S-100 music board.



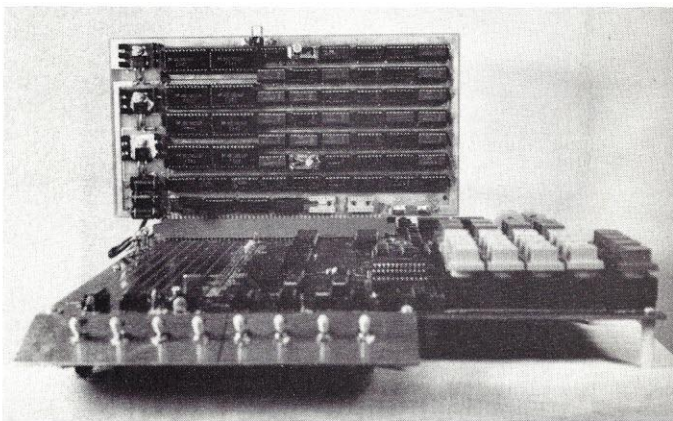


Photo 2. S-100 music board installed in Z-80 Starter System.

additional CPU registers found in the Z-80 is relative addressing. In this mode a new address is determined by adding a two's complement displacement to the previous address. For example, a relative jump might refer to an instruction ten memory locations ahead in the program. The ZBUG monitor has a routine that automatically calculates these displacements and inserts them in the proper memory locations.

The advantage of relative addressing is that when these in-

structions are assembled, absolute addresses need not be specified. This is important for producing relocatable code; if a new instruction is to be inserted somewhere in the program, new addresses do not have to be computed for instructions utilizing relative addressing. In addition, block move instructions facilitate transfer of whole program sections in case such insertions are needed.

A powerful set of interrupt instructions is offered by the Z-80, and these are utilized by the

|      |    |    |            |                              |
|------|----|----|------------|------------------------------|
| 3000 | 3E | CF | LD A,0CFH  | Mode word for PIO section B. |
| 3002 | D3 | 83 | OUT(83H),A | Send to control register.    |
| 3004 | 3E | FF | LD A,0FFH  | Control word for PIO B.      |
| 3006 | D3 | 83 | OUT(83H),A | Send to control register.    |
| 3008 | DB | 81 | IN(A),81H  | Input sense switches to A.   |

Table 1. Sense Switch routine.

Z-80-CTC and Z-80-PIO chips as well.

In order to take full advantage of the capabilities of the Z-80 Starter System, you should read the following two books: the *Mostek Microcomputer Z-80 Data Book* for hardware information and the *Mostek Z-80 Programming Manual* for descriptions of the instructions. Both are available for a few dollars each, and have returned this investment in time saved many times over.

### S-100 Expansion

The Z-80 Starter System comes with two positions wired for Imsai-type S-100 solder tail edge connectors (not included in the kit). However, not all the standard S-100 bus signals are available at the connectors.

Therefore, any desired expansion must be carefully planned in order that all the required bus signals can be made available.

I decided to aim for an additional 8K of RAM as the first S-100 addition. SD Systems recommends that only static memory be used in the Z-80 Starter System. Their 4K board evidently plugs in with no modification, but it is no longer available.

I wrote to a number of manufacturers of 8K static memory boards, requesting a schematic so that I could determine which board would interface to my system with minimum modification to the computer. As a matter of principle, I decided to make no modifications to any S-100 boards installed in my system.

The 8K static memory board offered by Digital Research Corp. (PO Box 401247, Garland TX 75040) seemed to be the answer. The only S-100 bus signal it needed that was not provided by my computer was PDBIN. Fig. 1 shows a simple circuit using an extra inverter in U37 and the Z-80 signal  $\overline{RD}$ , which will produce PDBIN. It requires soldering in only two jumpers. When I plugged the memory board in, a memory test program (given in the back of the *Mostek Data Book*) showed that everything was working perfectly... and it has continued to do so. The memory board was addressed at 4000H, which is the third 8K segment.

One additional S-100 bus signal often needed for output is PWR. Fig. 2 shows how to obtain this signal using a spare AND gate in U36 and WR from the Z-80.

To aid in debugging software and new hardware, I have mounted eight SPDT sense switches on an aluminum panel and interfaced them to the Z-80-PIO parallel port B. Table 1 shows a program that initializes

### Program listing.

Initialize the duration address table:

|      |    |    |    |                   |                            |
|------|----|----|----|-------------------|----------------------------|
| 2000 | CD | A7 | 06 | CALL UFOR4        | Clear display              |
| 03   | 21 | 29 | 21 | LD HL, DURADTAB   | Point to dur. addr. table. |
| 06   | 3E | 01 |    | LD A, 01H         | Put 1 in low byte          |
| 08   | 11 | 02 | 00 | LD DE, 0002H      | of duration addr. table    |
| 0B   | 06 | 08 |    | LD B, 08H         | for each voice.            |
| 0D   | 77 |    |    | TABL: LD (HL), A  |                            |
| 0E   | 19 |    |    | ADD HL, DE        |                            |
| 0F   | 10 | FC |    | DJNZ, TABL-\$     |                            |
| 11   | 21 | 2A | 21 | LD HL, DURADTAB+1 |                            |
| 14   | 3E | 40 |    | LD A, 40H         | Put 40H, 44H, 48H etc      |
| 16   | 06 | 08 |    | LD B, 08H         | in high byte of            |
| 18   | 77 |    |    | TABH: LD (HL), A  | duration addr. table       |
| 19   | 19 |    |    | ADD HL, DE        | for eight voices.          |
| 1A   | C6 | 04 |    | ADD A, 04H        |                            |
| 1C   | 10 | FA |    | DJNZ, TABH-\$     |                            |

Set up the current duration table:

|      |    |    |    |                    |                                     |                            |
|------|----|----|----|--------------------|-------------------------------------|----------------------------|
| 201E | D9 |    |    | EXX                | Exchange registers.                 |                            |
| 1F   | AF |    |    | XOR A              | Clear A.                            |                            |
| 20   | 21 | 39 | 21 | LD HL, NVOC        | Point to number of voices.          |                            |
| 23   | 4E |    |    | LD C, (HL)         | No. of voices to C.                 |                            |
| 24   | 11 | 21 | 21 | LD DE, DURTAB      | Point to duration table.            |                            |
| 27   | FD | 21 | 29 | 21                 | LD IY, DURADTAB                     | Point to dur. addr. table. |
| 2B   | FD | 6E | 00 | LOOP: LD L, (IY+0) | Get duration address                |                            |
| 2E   | FD | 66 | 01 | LD H, (IY+1)       | in HL.                              |                            |
| 31   | ED | A0 |    | LDI                | Move (HL)→(DE), dec C, inc. DE, HL. |                            |
| 33   | B9 |    |    | CP C               | Is C=0?                             |                            |
| 34   | 28 | 06 |    | JR Z, CONT-\$      | If yes, continue.                   |                            |
| 36   | FD | 23 |    | INC IY             | If no, keep transferring            |                            |
| 38   | FD | 23 |    | INC IY             | durations.                          |                            |
| 3A   | 18 | EF |    | JR LOOP-\$         |                                     |                            |



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Initialize the display of beat number and bar number:

|                |       |              |                           |
|----------------|-------|--------------|---------------------------|
| 203C 3C        | CONT: | INC A        | A and C still 0.          |
| 3D 57          |       | LD D,A       | Put 1 in beat register.   |
| 3E 5F          |       | LD E,A       | Put 1 in bar register.    |
| 3F DD 21 F9 23 |       | LD IX,DSMEM2 | Dend D to display memory. |
| 43 CD 3C 06    |       | CALL UFOR1   |                           |
| 46 7B          |       | LD A,E       | Send E to display memory. |
| 47 DD 21 FB 23 |       | LD IX,DSMEM4 |                           |
| 4B CD 3C 06    |       | CALL UFOR1   |                           |

Initialize Z80-CTC as a real-time clock:

|            |             |                                 |
|------------|-------------|---------------------------------|
| 204E D9    | EXX         | Exchange registers.             |
| 4F 3E 35   | LD A,35H    | Timer, prescale 256, no int.    |
| 51 D3 84   | OUT (84H),A | CTC/0 control word.             |
| 53 3E 20   | LD A,20H    | Time constant=32D.              |
| 55 D3 84   | OUT (84H),A | CTC/0 time constant.            |
| 2057 ED 47 | LDI A       | Interrupt vector hi byte=20H.   |
| 59 3E 8E   | LD A, 8EH   | Interrupt vector lo byte=8EH.   |
| 5B D3 84   | OUT(84H),A  | Interrupt vector to CTC.        |
| 5D 3E D5   | LD A,0D5H   | Counter,+ve slope, int. enable. |
| 5F D3 87   | OUT(87H),A  | CTC/3 control word.             |
| 61 3E 0A   | LD A,TEMPO  | 10D=fast, 24D=slow.             |
| 63 D3 87   | OUT(87H),A  | CTC/3 time constant.            |

Send the first note to all voices:

|                |                    |                            |
|----------------|--------------------|----------------------------|
| 2065 AF        | XOR A              | Clear A.                   |
| 66 21 39 21    | LD HL,NVOC         | Point to number of voices. |
| 69 46          | LD B,(HL)          | No. of voices in B.        |
| 6A 0E A0       | LD C,0A0H          | Port for voice 1.          |
| 6C FD 21 29 21 | LD IY,DURADTAB     | Point to dur. addr. table. |
| 70 FD 6E 00    | FIRST: LD L,(IY+0) | Point to duration.         |
| 73 FD 66 01    | LD H,(IY+1)        |                            |
| 76 2B          | DEC HL             | Point to note.             |
| 77 ED A3       | OUTI               | Output note, inc HL,dec B. |
| 79 B8          | CP B               | Is B=0?                    |
| 7A 28 07       | JR Z,DONE-\$       | If yes, finish.            |
| 7C FD 23       | INC IY             | Next voice.                |
| 7E FD 23       | INC IY             |                            |
| 80 0C          | INC C              | Next port.                 |
| 81 18 ED       | JR FIRST-\$        |                            |

Enable interrupts and enter display routine in monitor:

|             |            |                    |
|-------------|------------|--------------------|
| 2083 ED 5E  | DONE: IM 2 | Interrupt mode 2.  |
| 85 FB       | EI         | Enable interrupts. |
| 86 C3 F4 00 | JP DISUP   | Jump to display.   |
| 208E 90 20  |            | Interrupt vector.  |

#### Interrupt Service Routine

Update display, check if song is over. If so, clear all voices:

|                |                     |                                |
|----------------|---------------------|--------------------------------|
| 2090 08        | EX AF,AF'           | Save registers.                |
| 91 D9          | EXX                 |                                |
| 92 DD E5       | PUSH IX             |                                |
| 94 0C          | INC C               | Increment interrupt counter.   |
| 95 79          | LD A,C              | Bring to A.                    |
| 96 FE 0C       | CP 0CH              | Is it 12?                      |
| 98 28 22       | JR Z,BEAT-\$        | If yes, jump to BEAT.          |
| 9A FE 18       | CP 18H              | Is it 24?                      |
| 9C 28 1E       | JR Z,BEAT-\$        | If yes, jump to BEAT.          |
| 9E FE 24       | CP 24H              | Is it 36?                      |
| A0 28 1A       | JR Z,BEAT-\$        | If yes, jump to BEAT.          |
| A2 FE 30       | CP 30H              | Is it 48?                      |
| A4 20 1F       | JR NZ,VOICE-\$      | If no, jump to VOICE.          |
| A6 0E 00       | LD C,00H            | Clear C, since bar is over.    |
| A8 1C          | INC E               | Increment bar counter.         |
| A9 21 3A 21    | LD HL,BARCT         | Point to number of bars.       |
| AC 7E          | LD A,(HL)           | Bring in number of bars.       |
| AD BB          | CP E                | Finished song?                 |
| AE 28 52       | JR Z,QUIT-\$        | If yes, jump to QUIT.          |
| B0 7B          | LD A,E              | Move bar count to displ. mem.  |
| B1 DD 21 FB 23 | LD IX,DSMEM4        |                                |
| B5 CD 3C 06    | CALL UFOR1          |                                |
| B8 16 01       | LD D,01H            | Reset beat counter.            |
| BA 18 01       | JR BTDIS-\$         | Display beat number.           |
| BC 14          | BEAT: INC D         |                                |
| BD DD 21 F9 23 | BTDIS: LD IX,DSMEM2 | Move beat count to displ. mem. |
| C1 7A          | LD A,D              |                                |
| C2 CD 3C 06    | CALL UFOR1          |                                |

this port as an input port with no handshaking. Fig. 3 shows the circuit diagram for the sense switches. The panel and the switches can be seen in position in Photos 1 and 2.

#### **Application — Eight-Voice Music Board**

The Z-80 Starter System with the Z-80-CTC counter-timer chip is admirably suited for process control applications. The example which I have implemented is an eight-voice music system, but the programming methodology can be used for any sequence timing control function. The music board, built to S-100 standards, produces the audio tones, and the computer is used only to control which notes will be heard and in what sequence. The eight-voice capability means that eight different notes can be played simultaneously, although often several of the voices will be playing the same notes but in different octaves. At any rate, it is possible to create multi-part harmony, which was my aim when I set out to build this board.

#### **How the Hardware Generates Music**

Fig. 4 shows a schematic of one voice of the music board, plus the common control circuitry. Table 2 shows the circuit pin-outs. The primary frequencies are generated as square waves by the MK50240 Top Octave Generator IC10 (see the references for more information on this method of generating audio tones with hardware). It does this by dividing the 2 MHz system clock (prescaled to 125 kHz by IC9) by 12 separate integer values, resulting in 12 chromatic tones in one octave of the equal-tempered scale.

After buffering for fan-out to eight voices occurs, the desired note is selected by multiplexer IC13, and the resulting frequency is divided by 2, 4, 8 and 16 in binary counter IC14. These notes in four different octaves are selected in multiplexer IC15 and passed onto the audio circuitry.

Each voice is addressed as an output port by the computer, with logic and decoding done in ICs 1-3. The information sent on



the data bus to each port consists of an 8-bit word. The lower four bits select 1 of 12 notes of the scale, while the upper four bits determine in which of the four octaves the desired note will be.

The range of notes available is from C#, two octaves below middle C, to high C, two octaves above middle C. This roughly corresponds to the span of notes used by a dance band.

Once the data word is passed from the CPU to the music board, it is held by the latches ICs 7 and 8 until a new note (or rest) is requested for that voice. The audio outputs of all eight voices are summed by op amp IC16 and sent to audio Amp IC17.

I constructed this eight-voice music board on a Seals wire-wrap board, and, as shown in Photo 2, every IC position available is used. Port addresses are A0-A7 hex for voices 1-8.

### Music Software

The control program below is not unique to the system I have constructed, except for various entries to the ZBUG monitor and the port addresses used. The monitor program is used only to update the display, which shows the current bar number and beat number (1-4). This function could easily be eliminated or modified by the individual user.

In order to play a tune, a song table must be entered in memory. I have assigned 1K of RAM for each of the eight voices, starting at 4000H for voice 1. This is enough for approximately 100-150 bars of music if used fully. Each note entered in the song table consists of a 1-byte hexadecimal word representing the note and octave, as described previously, followed by a 1-byte hexadecimal word representing the desired duration of that note.

The octaves starting at the lowest are 8X, 9X, AX and BX, where X is the four-bit number for the note. The 12-tone scale begins at C# and ends at C natural; it uses the hexadecimal numbers 0H through BH. Thus, middle C becomes the 8-bit

number 9BH, while the lowest C# is denoted by 80H. A rest (no note) is 00H. Table 3 gives the notes and their hexadecimal equivalents.

The durations are given by assigning the decimal number 12 (0CH) to a quarter note. A whole note would then be 48D (30H), and a sixteenth note would be 3D (03H). Table 4 gives the musical symbols for the common note durations and their hexadecimal representations.

The program operates as an interrupt-driven sequence timer and requires a real-time clock to generate the interrupts. This function is provided by two sections of the Z-80-CTC counter-timer. The first section, channel 0, counts system clock pulses and decrements an internal register. When zero is reached, the zero time-out pulse is used as in-

|         |            | Gnd | +5 V | +12 V | -12 V + 8 V unreg |
|---------|------------|-----|------|-------|-------------------|
| IC1     | 74LS138    | 8   | 16   |       |                   |
| IC2,6   | 74LS04     | 7   | 14   |       |                   |
| IC3     | 74LS30     | 7   | 14   |       |                   |
| IC4,5   | 74LS08     | 7   | 14   |       |                   |
| IC7,8   | 74LS75 +   | 12  | 5    |       |                   |
| IC9     | 74LS74     | 7   | 14   |       |                   |
| IC10    | MKS0240    | 3   | -    | 1     |                   |
| IC11,12 | CD4010*    | 8   | 1    | 16    |                   |
| IC13    | 74150**    | 12  | 24   |       |                   |
| IC14    | 74177**    | 7   | 14   |       |                   |
| IC15    | 74LS151**  | 8   | 16   |       |                   |
| IC16    | (1/2)LM747 | -   | -    | 13    | 4                 |
| IC17    | LM386      | 4   | -    |       | 6                 |

\*4 needed for eight voices

+16 needed for eight voices

\*\*8 needed for eight voices

Table 2. Fig. 5 pin-outs.

put for the channel 3 counter. These pulses, in turn, decrement an internal register, and an interrupt is issued to the CPU when zero is reached. The combination of two counters in cascade allows a wide range of real-time clock rates.

Fig. 5 shows the jumper con-

nection required in order to cascade the two channels. This modification does not affect the regular functions of the Z-80-CTC, as it is used by the monitor program. The two internal registers and the interrupt vector are initialized before playing a song. To change the tempo

Decrement durations for each voice, output notes, update tables:

|                |                     |                                |
|----------------|---------------------|--------------------------------|
| 20C5 C5        | VOICE: PUSH BC      | Save interrupt counter.        |
| C6 21 39 21    | LD HL,NVOC          | Point to number of voices.     |
| C9 7E          | LD A,(HL)           | Bring number of voices.        |
| CA 0E A0       | LD C,OA0H           | Port for voice 1.              |
| CC FD 21 29 21 | LD IY,DURADTAB      | Point to duration addr. table. |
| D0 DD 21 21 21 | LD IX,DURTAB        | Point to duration table.       |
| D4 DD 35 00    | CHEKDUR: DEC (IX+0) | Decrement current duration.    |
| D7 28 0C       | JR Z,OUT-\$         | If=0, proceed to OUT.          |
| D9 3D          | CHKVOC: DEC A       | Next voice.                    |
| DA 28 1E       | JR Z,EXIT-\$        | Exit if done.                  |
| DC 0C          | INC C               | Next port.                     |
| DD FD 23       | INC IY              |                                |
| DF FD 23       | INC IY              |                                |
| E1 DD 23       | INC IX              | Next duration.                 |
| E3 18 EF       | JR CHEKDUR-\$       |                                |
| E5 FD 6E 00    | OUT: LD L,(IY+0)    | Point to current duration.     |
| E8 FD 66 01    | LD H,(IY+1)         |                                |
| EB 23          | INC HL              | Point to note.                 |
| EC ED A3       | OUTI                | Output note, inc HL, dec B.    |
| EE 46          | LD B,(HL)           | Bring next duration to B.      |
| EF DD 70 00    | LD (IX+0),B         | Update duration table.         |
| F2 FD 75 00    | LD (IY+0),L         | Update duration addr. table    |
| F5 FD 74 01    | LD (IY+1),H         | for this voice                 |
| F8 18 DF       | JR CHKVOC-\$        | Next voice.                    |

Prepare to return to main program:

|             |                  |                           |
|-------------|------------------|---------------------------|
| 20FA C1     | EXIT: POP BC     | Restore registers.        |
| FB DD E1    | POP IX           |                           |
| FD D9       | EXX              |                           |
| FE 08       | EX AF,AF'        |                           |
| FF FB       | EI               |                           |
| 2100 ED 4D  | RETI             | Return from interrupt     |
| 02 21 39 21 | QUIT: LD HL,NVOC | Point to no. of voices    |
| 05 46       | LD B,(HL)        | Bring no. of voices to B. |
| 06 0E A0    | LD C,OA0H        | Port for voice 1.         |
| 08 AF       | XOR A            | Clear A.                  |
| 09 ED 79    | CLEAR: OUT(C),A  | Clear voice.              |
| 0B 0C       | INC C            | Next voice.               |
| 210C 10 FB  | DJNZ,CLEAR-\$    | Loop if not finished.     |
| 0E C1       | POP BC           | Restore registers.        |
| 0F DD E1    | POP IX           |                           |
| 11 D9       | EXX              |                           |
| 12 08       | EX AF,AF'        |                           |
| 13 D1       | POP DE           | Takes care of stack.      |
| 14 C3 AE 00 | JP MON           | Jump to monitor.          |



# Table and constant area:

|      |                    |
|------|--------------------|
| 2121 | DURTAB: DEFS 08H   |
| 29   | DURADTAB: DEFS 0FH |
| 39   | NVOC: DEFB 1H      |
| 3A   | BARCT: DEFB 1H     |

Duration table.  
Duration address table.  
Number of voices used in song.  
Number of bars to be played + 1.

## Song Table Area:

|           |         |
|-----------|---------|
| 4000-43FF | Voice 1 |
| 4400-47FF | Voice 2 |
| 4800-4BFF | Voice 3 |
| 4C00-4FFF | Voice 4 |
| 5000-53FF | Voice 5 |
| 5400-57FF | Voice 6 |
| 5800-5BFF | Voice 7 |
| 5C00-5FFF | Voice 8 |

## ZBUG monitor routines used and cross reference:

|        |                     |                              |
|--------|---------------------|------------------------------|
| UFOR4  | 2000                | Clear display.               |
| DSMEM2 | 203F 20BD           | Display memory buffer.       |
| UFOR1  | 2043 204B 20B5 20C2 | Write to display             |
| DSMEM4 | 2047 20B1           | Display memory buffer.       |
| DISUP  | 2086                | Display update routine.      |
| MON    | 2114                | Monitor program entry point. |

## I/O Ports used:

|                            |                                 |
|----------------------------|---------------------------------|
| 81 PIO B data register     | } Used with sense switches only |
| 83 PIO B control register  |                                 |
| 84 CTC/0 control register  |                                 |
| 87 CTC/3 control register  |                                 |
| A0-                        |                                 |
| A7 Music board voices 1-8. |                                 |

by one and tested for zero.

If zero has been reached for a particular voice, it is time to get a new note from the song table, output that note to the correct port and bring the new note's duration into the current duration table. The computer scans all the voices being used at each interrupt, but actually spends most of its time in a loop in the monitor program, updating the display and checking the keyboard for input.

Since the Z-80 CPU has a dual set of registers, one set is used for the music control and the other set is used for the display routine. This minimizes stack operations and allows clock times to be stored in the CPU registers.

Location 2139H holds a number from 1 to 8, representing the number of voices which will be used to play the song, beginning with voice 1. Location 213AH holds a number that should be set to one more than the number of four-beat music bars that you wish to play.

or speed of the music, a different number may be stored in location 2062H. Execution begins at location 2000H, after the RESET switch is pushed.

Fig. 6 shows a flowchart for the music program listing. Operation of the program centers around several tables set up in RAM. The first table contains the addresses of the current note durations, one for each voice. This allows the computer to keep track of how far each voice has progressed through its song table.

Another table in RAM has the actual current durations for each voice. Whenever an interrupt occurs — once every 1/48th of a four-beat bar — each voice's current duration is decremented

In many songs it is common to find two notes of the same name following one another. In order to produce a gap or articulation between them, you must insert a rest of short duration. For example, the first two notes of "Yankee Doodle" are quarter notes of middle C. They would sound like a half note without the articulation. Thus, they should be entered in the song table as 9B 0B 00 01 9B 0C. Notice that the first quarter note is reduced in duration from 0C to 0B to allow for the short rest of duration 01.

## Conclusion

My experience with the Z-80 Starter System from SD Systems (PO Box 28810, Dallas TX 75228) has been a positive one. The possibilities for expansion are limited only by the ingenuity of the user. For example, you could add a memory-mapped video display board and an ASCII keyboard virtually by plugging them in and modifying the monitor program.

With these and an 8K or 16K memory board, you could implement with minimal effort. In short, the Z-80 Starter System




|    |    |   |   |    |    |
|----|----|---|---|----|----|
| C# | 80 | → |   | C# | A0 |
| D  | 81 |   |   | D  | A1 |
| D# | 82 |   |   | D# | A2 |
| E  | 83 |   |   | E  | A3 |
| F  | 84 |   |   | F  | A4 |
| F# | 85 |   |   | F# | A5 |
| G  | 86 |   |   | G  | B6 |
| G# | 87 |   |   | G# | B7 |
| A  | 88 | → |  | A  | B8 |
| A# | 89 |   |   | A# | B9 |
| B  | 8A |   |   | B  | BA |
| C  | 8B |   |   | C  | BB |
| C# | 90 |   |   | C# | 0B |
| D  | 91 |   |   | D  | B1 |
| D# | 92 |   |   | D# | B2 |
| E  | 93 |   |   | E  | B3 |
| F  | 94 |   |   | F  | B4 |
| F# | 95 |   |   | F# | B5 |
| G  | 96 |   |   | G  | B6 |
| G# | 97 |   |   | G# | B7 |
| A  | 98 |   |   | A  | B8 |
| A# | 99 |   |   | A# | B9 |
| B  | 9A |   |   | B  | BA |
| C  | 9B | → |  | C  | BB |

Table 3. The notes and their hexadecimal equivalents.












| Note                    | Symbol  | Hex representation |
|-------------------------|---|--------------------|
| Whole note              |  | 30                 |
| Dotted half note        |  | 24                 |
| Half note               |  | 18                 |
| Dotted quarter note     |  | 12                 |
| Quarter note            |  | 0C                 |
| Dotted eighth note      |  | 09                 |
| Eighth note             |  | 06                 |
| Sixteenth note          |  | 03                 |
| Triplet quarter notes   |  | 08 each note       |
| Triplet eighth notes    |  | 04 each note       |
| Triplet sixteenth notes |  | 02 each note       |

Table 4. Note symbols and their hexadecimal durations.

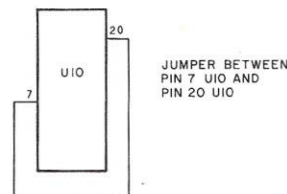


Fig. 5. Jumper required to cascade sections 0 and 3 of Z-80-CTC in order to make a real-time clock for controlling the music board.



provides an excellent way to get into microcomputing inexpensively, while still allowing an expansion capability for more advanced applications. ■

#### References

1. Schneider, T. G., "Simple Approaches to Computer Music Synthesis," *BYTE*, October 1977, p. 140.
2. Schweber, B., "Top-Octave Generators Make Beautiful Music," *EDN*, April 5, 1979, p. 71.

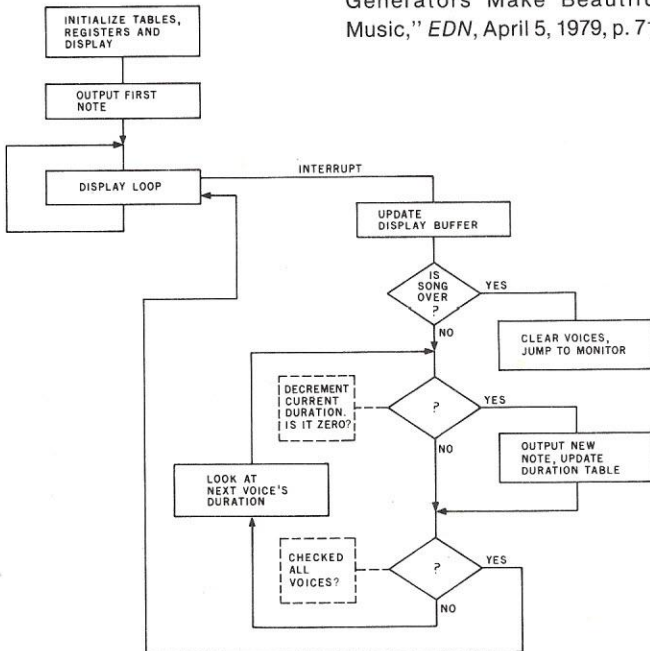


Fig. 6. Flowchart of Z-80 program used to control eight-voice music board.

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*The following is an introduction to programmed instruction. This will whet your appetite for next month's issue, which will feature microcomputers in education.*

---

**T**ension was evident in the man's face. He had tried suggestion, logic, bribery (a double-dip bubble-gum sundae) and now he was ready to get physical. His nine-year-old son was fighting for the survival of a galaxy in living Compucolor. He only had a few phasor shots left, power to the shields was failing and the last Klingon was in an adjacent sector. Luckily, a final, well-placed shot ended the game and the parental conflict. The kid yelled "thanks" as he left through the door a

microsecond ahead of his father.

\* \* \*

I was in the Computer Terminal, a store in San Mateo CA. Unlike so many others, this store was located in the middle of the downtown area, not at the dark end of some backwater shopping center. It had an attractive window display, and inside were systems ready for people to use. The attitude of the clerks was "helpful" (remember how that used to

be?) and the walk-in traffic of passersby, particularly preteen kids, was great. The parents were usually dragged in exhibiting the full force of well-developed sales resistance. This gradually changed to mild approval and interest until ... somebody mentioned price. Then, with glazed eyes and fixed but drooling smiles, they dragged junior out of the store before "you break somethin' I'll have to pay for."

The interest of kids, particularly preadolescents, in computers is natural. The powerful things that an 8- to 16-year-old can manipulate are limited. With a microcomputer, they are suddenly presented an opportunity to control an interactive TV set. They aren't particularly awed or bothered by technical complexities. The computer is simply another thing to be mastered, and they will master it by whatever rules they find.

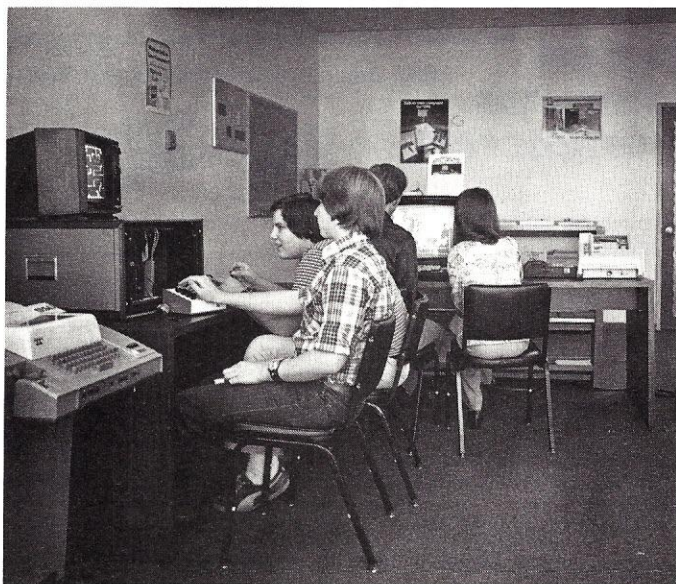
The enthusiasm shown by the kids in the Computer Terminal was refreshing and contagious. As an educator, I knew teaching machines have been around for a long time and that computers have been used in teaching for several years. It seemed obvious that the great availability and lower cost of microcomputers could be combined with the natural interest of the students to make some

effective teaching machines. The purpose of this article is to bring together various facts and experiences from the field of education and to lay them out for use by the computer hobbyist and programmer. I'm going to discuss some old and new experiments, theories and uses for computers in education. Also included is a checklist to help program writers write the most effective and complete programs possible, even with limited memory.

## Some History

In the Socratic method of teaching the teacher asks a series of questions that lead the student to the desired insight or knowledge. This is probably the earliest known example of programmed instruction, that is, teaching in a step-by-step manner toward a formal goal. Programmed instruction, of course, doesn't need computers or machines; but teaching machines do need programmed instruction. A great deal of programmed instruction is in printed form, but the computer is capable of more effective interaction, flexibility and reinforcement than any printed sheet.

An early pioneer of programmed instruction was Sidney L. Pressey. His main goal was limited to giving students the immediate results



*This is a typical scene at the Computer Terminal in San Mateo CA. There is usually a crowd of young customers working with the display computer.*



of tests by having them respond to test questions using a variety of electrical and mechanical devices. (If that was his goal in 1920, why does it still take a week to get an IBM sheet corrected?) His lifetime work has earned him a place as the "father" of the teaching machine. Two other later researchers worked, with a lot of pushing and pulling, to further the idea of learning by machine interaction.

B. F. Skinner is generally well known as the developer of the "Skinner Box," which taught generations of rats and pigeons many things their mothers didn't know. Skinner's method is one of careful reinforcement of the desired responses in the learner's behavior. The reinforcement is the most important focus of Skinner's work, which has, in the past, been in strong contrast to that of Norman A. Crowder, who puts emphasis on leading or coaching the learner through the material.

The differences in Crowder's work and Skinner's are mainly in approach. Despite all of the sound and fury put up by their advocates over the years, their theories are not incompatible. Let's now take a look at these theories and see how we can apply them in a practical way.

### A Little Psychology

Skinner's work with animals produced a great deal of information on reinforcement, which is applicable to human beings—sort of. His experiments dealt with the relationship between: (1) the type and amount of feedback and its role in learning and (2) the way reinforcement is given and learning. Both of these are important if we are going to make our computers into effective tutors.

Research indicates that the type of feedback is not critical as long as it is positive and effective over the entire learning session. This means we don't have to make our machines sound all of their bells and whistles for every correct response, but we don't want them to just ignore a right answer, either. Flexibility and



*Though technically a minicomputer, this powerful Jacquad J100 is showing a pretty Hawaiian high-school sophomore some of the things micros and minis can do for education. Dual disks and plenty of internal memory give room for elegant programs, but a lot can be done with 8K and a cassette deck, too!*

variety within a small repertoire of reinforcements are needed—a little creative programming and the flexibility of a microcomputer! The importance of the way reinforcement is given is a bit trickier to interpret. The "schedule of reinforcement" is referred to as being either "continuous" or "intermittent."

Continuous describes the case where *every* correct response made by the learner is rewarded in some way. This mode is (with good reason) the one we are the most familiar with. In intermittent reinforcement, only *some* of the correct responses are rewarded—either on a ratio basis (reward every third correct response, for instance) or on an interval basis (time). The ratio or the interval may be fixed or may vary during the training session.

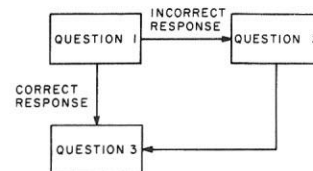
Intermittent reinforcement explains why you think you have to hold your breath and cross your fingers in order to get that tape recorder to load a program into the computer. Maybe it works once every

three times—you remember. Intermittent reinforcement explains a lot of what we call superstition (or does superstition explain intermittent reinforcement?).

Research shows that continuous reinforcement is effective in initially teaching some desired response. The glitch is that intermittent reinforcement seems to lead to longer retention of what is learned. Since we want the best of both worlds, it seems that the best way to provide reward for positive responses would be to first reward every correct response (continuous) and then later reward some ratio of correct responses (intermittent). This should lead to rapid learning and long retention of one learned response.

Care must be taken in applying the research on intermittent reinforcement. The effectiveness of the intermittent reinforcer only applies to repeated instances of the *same* desired response. In other words, don't reward the subject for correctly recognizing "pet"

as a verb in a sentence and then ignore the correct recognition of "pet" as a noun in another sentence. Intermittent reinforcement only works for the same identical response shown repeatedly. Since (as we shall see) we will try to repeat very few correct responses, intermittent reinforcement will have only limited use for us. However, a clever programmer can make good use of this technique when repetition of correct responses does occur—perhaps in conjunction with some new learning. An example might be: RECEIVE is correct. Also, glad to see you remembered e before i (assuming that the learner had to spell out the word and had previously learned "i before e except



*Fig. 1. Linear program format.*



after c").

Shaping is another useful technique developed by Skinner. In shaping, rewards are given for actions or responses successively closer to the desired goal. In working with a computerized system, we may be better able to use the system to recognize "better and better" answers and to reward them properly. Behavior shaping is common in everyday life. It is found in dramatic and athletic coaching, peer and parent pressure and in business and political relationships.

Shaping may take up a lot of program memory, but it can be useful in teaching particularly complex tasks. Shaping may (and usually does) take place over a series of small steps or programs. It can be seen as a

unifying theme among a series of programs, each of which fits into the memory available to the particular program.

Although it is unfair to treat the work of B. F. Skinner in a few short paragraphs, we must be careful about what we, as novice formal educators, can easily and practically apply. Let's take a look at the work of Crowder, the researcher whose focus is on *what is presented* rather than *how it is reinforced*.

Crowder likens programmed instruction to private tutoring. He did a great deal of work with the U.S. Air Force in teaching electronic troubleshooting skills. He analyzed what a live tutor did when working with a small group of students. His results showed that the process: (1) presented new infor-



*Keyboard skills are both a part of and a valuable spin-off from computerized instruction. Many educators are calling for the development of these skills in the early elementary grades.*

#### Glossary

**Advance Organizers:** Introductory information that can help in learning what follows.

**Biofeedback:** Information received by a person about his body functions. Typically concerns heart rate, respiration, brain waves, etc.

**Branching Program:** Allows a variety of paths through program material. Usually uses multiple-choice questions.

**Computer Assisted Instruction (CAI):** What the use of computerized teaching machines is called to make them less threatening to teachers.

**Discovery Learning:** Acquisition of new information, largely through the learner's own efforts. Good, but it takes a long time.

**Frame:** A unit of an instructional program. A frame is usually ended by having the learner make a response or engage in a specific activity.

**Intermittent Reinforcement:** Reinforcement is not provided for each repetition of the same correct response. Ratios or intervals may determine which repetitions of the response are rewarded.

**Knowledge of Results:** What's the score? How well did I do? For our purposes, knowledge of results should be provided immediately after each response or activity.

**Negative Reinforcer:** Unpleasant feedback to a response. We don't want to use it.

**Programmed Instruction:** Material presented in small steps or frames. Usually aimed at an overall course of instruction.

**Reinforcement:** Words, signs, events, symbols, etc., that take place as a result of the learner's activity or response.

**Remedial Frame:** In a branching program, that frame of review or reexplanation a learner might go to as a result of an incorrect response.

**Response:** An answer, action or activity engaged in by the learner as a part of the programmed instruction.

**Schedule of Reinforcement:** The manner in which reinforcement is presented (intermittent, continuous, etc.).

**Shaping:** A system by which complex behavior is taught by rewarding responses that are closer and closer to the one(s) desired.

#### Branching Program

Allows individual progress. Tries to insure all material is learned. Takes more memory space. Usually only uses multiple-choice questions.

#### Linear Program

Uses small steps and internal review to insure mastery of information. Less complex program can use many different forms of response.

*Table 1. Program comparison.*

mation to the student; (2) required the student to use that new information, usually to answer questions (can you think of other ways?); (3) took appropriate action in responding to what the student did (i.e., rewarding, going on to new material, reviewing in a different manner, etc.). An easy program to write, right? Yes, but...

Crowder's technique contains a limited amount of information and a companion multiple-choice question. The learner makes a response to the question and then proceeds to the next step indicated by the choice made. If the correct response was chosen, the next step will be additional new information; if the wrong answer is given, review and appropriate reemphasis will be given. Educators call this a "branching program," contrasted to a "linear program" (favored by Skinner), in which all learners progress through the same material in the same sequence. Internal review and smaller

steps are used to insure that all learners "get" the information in the linear program format. (See Fig. 1.)

Branching learning programs appeal to most computer programmers because the learner can "flow through" the material in a more personal and individual manner. However, the technique is basically limited to multiple-choice questions, which are not always the best for several reasons that we'll discuss later. The balance is shown in Table 1.

For our purposes we should write programs to use both forms of construction. The type and complexity of the material should be the guide to how much memory to devote to fancy branching and remedial or review lessons.

Research by E. L. Thorndike and many others has shown the role of negative reinforcement in programmed instruction and in teaching machines to be very well defined—*never, not ever, nohow!* The responses "wrong,



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dummy!" or "boy, did you blow it!" are absolutely guaranteed to create more failures than successes.

### Theory

Testing is a detailed science, and it is difficult for a classroom teacher to make a good test. There are many "cook-book" recipes for writing test questions, and several things keep boiling to the top:

- Multiple-Choice Questions—easy to grade; very hard to write; useful for leading to programmed results (branching program).
- True and False—used only by mean teachers who like to

be approximately equal in length. Too many "all of the above" or "none of the above" responses are a cop-out and should be avoided. (I won't even discuss true and false questions.)

Fill-in-the-blank (completion) questions are also hard to write, but if you are careful with your words, they are easier than multiple choice. To answer a completion item, the learner must recall the total setting of the information, thereby gaining valuable practice and intrinsic reward. A completion item should be concise, unambiguous and grammatically correct. Unnecessary and excessively technical



*Hard copy can serve as another form of positive reinforcement in itself. The computer can give these learners a positive report card to take home.*

trick kids. Don't use.

- Fill in the Blank—hard to write; very valuable for the student; harder for the computer to score.

Multiple-choice tests are a necessary evil. They are valuable diagnostic tools, but require a thorough knowledge of the subject and careful attention to the wording. Each multiple-choice question consists of a stem (the question) and the alternatives, two of which are foils (wrong), one is the plausible distractor (almost right) and one is the correct or keyed response. All responses should

words can give hidden clues to the correct response (sometimes not bad). Caution must be observed in picking the articles and verbs used—particularly to insure that one and only one response is correct. This is perhaps the hardest part of writing multiple-choice questions.

In writing instructional programs, as opposed to achievement tests, it is much more important for learners to get the correct answers. We want them to get the right answers and learn at the same time. The use of prompts or clues is appropriate then, and even more so in the case of completion

### Column I

- A. Reinforcement
- B. Presentation
- C. Scorekeeping

### Column II

- 1. Graphics
- 2. Color
- 3. Scrolling
- 4. Reverse
- 5. Expanded letters
- 6. Beeper
- 7. Printed sheets
- 8. Real objects and displays

A. 1, 2, 4, 5, 6

B. 1, 2, 3, 4, 5, 7, 8

C. 1, 2 is one set of answers. Did you have another?

*Table 2. Match the functions and capabilities. (Use as many from column II as you like.)*

items. Prompts can come from the context of the material. They can also come from rhymes, synonyms, antonyms and more:

- Rhyming Prompt: Jimmy Junction has three legs and a diode for a sister. Jimmy is called a \_\_\_\_\_. (transistor)
- Opposite: Heat causes things to expand. Cold causes them to \_\_\_\_\_. (contract)

Remember, it is important for learners to have a successful experience. The level of the learner and the complexity of the material must be carefully matched to ensure learning.

Discovery learning is a procedure wherein the learner is allowed to manipulate a given set of facts (numbers, figures, etc.) until he discovers their intrinsic relationship for himself. This procedure may lead to long retention of the material,

particularly among younger children who are learning basic principles. It is essentially a trial-and-error method, however, and, therefore, wasteful of time and probably computer memory. We might find ways to use the discovery-learning approach, but our approach will probably be more structured and directed.

### Brass Tacks

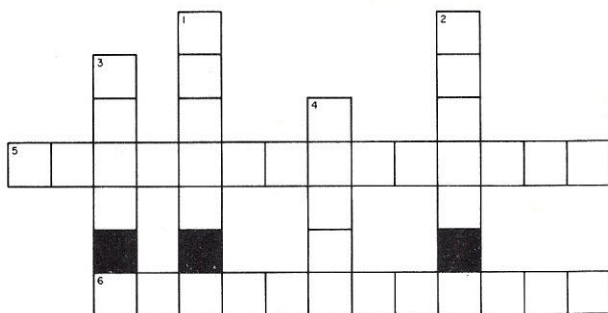
All that education research is fine, you say, but how do you really use it? We will now discuss how to write educational programs.

Most current teaching programs for microcomputers involve the subject of mathematics. I suspect this is due more to the inclinations of the programmers than to any feature of the computer media. Of all the elementary subjects, programmers probably remem-



*... and if you hold this down long enough, we can all go to recess!*





#### DOWN

1. Simulation
2. Tutor
3. Play a \_\_\_\_\_
4. Practice

#### ACROSS

5. If you hit five with a hammer, you would be a \_\_\_\_\_
6. Reference books.

#### ANSWERS

1. MODEL
2. TEACH
3. GAME
4. DRILL
5. NUMBERCRUNCHER
6. ENCYCLOPEDIA

Fig. 2. Crossword puzzle.

ber the most about mathematics; therefore, this is what they write programs about. Unfortunately, most of these programs seem to be little more than drills in mental arithmetic.

It is true that you never learn as much about a subject as when you teach it, so writing a teaching program is a beautiful opportunity to learn more about one of your other hobbies.

Many computerists are amateur radio operators. A simple primer on antenna theory could certainly take advantage of the graphics capability of some machines. The same principle applies to amateur potters, tailors, chefs, bakers and camel trainers. Some aspect of their hobbies could be taught in a step-by-step program.

Consider the following. To write a successful teaching program, you must (select one):

- A. Know your topic and provide a comprehensive description of it.
- B. Know your topic and limit it to information easily taught in small steps.
- C. Prepare your material in a

firm, standardized format.

- D. Use references to expert researchers and authors in the field.

If you responded with A you should remember we need to limit the topic to what we can handle in small steps. If you responded with C or D you should remember that flexibility and creativity are the keys to computerized instruction, not standardization and expert references.

If you responded with B you are correct and are off to a good start!

The use of the available memory space in a computer calls for the most complex strategy by programmers. Writing educational programs taxes this creativity. If you have a small amount of memory available, you might put the text and questions on paper and allow the computer to do the functions of scoring, branching and reinforcing. Ideally, concrete models, displays and examples will be used to augment the printed word. The graphics available on some machines can also be a

valuable teaching aid.

Probably the most important functions the computer performs as a teaching device are (select one):

- A. Presenting, scoring and teaching.
- B. Scoring, branching and reinforcing.
- C. Reinforcing, sorting and punishing.
- D. Branching, sorting and presenting.

If you chose B you were correct. What is your score now? If you were answering on a computer you would know, wouldn't you?

Here is a tougher one: Of the functions performed by a computer while teaching, the most important is probably \_\_\_\_\_.

If you didn't answer reinforcing, please go back and read the paragraphs about B. F. Skinner, but don't step into any wooden boxes.

Methods of reinforcement by computer can be written, graphic or audible. Various positive written phrases can be presented by the computer. A running tally can be kept and

the score incremented graphically for each correct response (color in blocks, send a rocket to the moon, put-on-a-happy-face subroutine), and/or the end-of-line beeper can be sounded.

To further test your knowledge of teaching concepts, see Table 2.

It has been found that the sequence of steps or (to use the lingo of the educators) "frames" is not critical in shorter programs. This is good news, since our available memory will probably only allow shorter programs.

Educators call the series of steps in a program \_\_\_\_\_. (Did you say frames? Good! Now you can wow 'em at the next PTA meeting.)

Because the mind has a tendency to order material in its own manner anyway, the order in which the material is presented in shorter programs is \_\_\_\_\_. (Not Critical)

Combining sensitive analog input devices with our computers can give us a great capability for biofeedback

#### Checklist

- Select a topic and level appropriate to your learner.
- Limit the topic so it can be covered in available time and memory space.
- Divide the topic into small steps or "frames" of instruction.
- Treat each frame separately and provide an appropriate question, example or learning activity for the termination of each frame.
- Vary the terminating questions and activities to include: multiple-choice questions, fill in the blank, matching, puzzles, games, rhymes, mnemonic devices, drills.
- Provide the appropriate reward to the learner for the successful completion of each question or activity.
- Vary the feedback to include: words of praise, knowledge of results, box scores, graphics, internal rewards (as in games, puzzles, etc.), sounds, external devices (dispensing coins, tokens, bubble-gum cards, etc.).
- Use program branching as available memory and subject matter allow.
- Use other learning aids along with the computer, such as: models, examples, written text (3 x 5 cards work well), illustrations, pictures, magnetic boards, paper and pencil, flip charts, diagrams.
- Try to use "shaping" to recognize the reward responses that are close, but not quite right.
- Use "shaping" in a more general sense to gradually bring your learners up to the desired level of performance.
- Do not ever use ridicule, shame, blame or any other form of negative reinforcement.
- Don't use true and false questions. They have no class.



training. Body parameters such as skin temperature, heart rate or blood pressure could be measured and the computer used to reward periods during which the desired effect is achieved. (Here is a chance to use partial reinforcement!) The advantage of the computerized biofeedback trainer lies in its flexible reinforcement capability, patience and ability to receive and evaluate several simultaneous inputs.

As an example, imagine three people hooked up to a microcomputer loaded with a biofeedback training program. The computer prints, "Close your eyes and make alpha waves until I sound my beeper."

It alternately monitors the inputs from the three analog-to-digital converters and counts to some appropriate number. After reaching a preset value in the count, it sounds its end-of-line beeper and says, "P for results." The results (time vs samples showing alpha waves) are graphed.

Educational applications of the microcomputer have all been tutorial or teaching in nature. There are other ways that the computer can be used in education. An example is the little crossword puzzle shown in Fig. 2.

It is generally accepted that a husband can't teach his own wife to drive. Today, too, it

seems as if parents can't teach their children anything they want them to learn. This can probably be attributed to our situation ethics and the diminished status of authority figures in our society. It is a sad but true commentary that the printed word, the computer and the television set are invested with more authority than are parents! But the crafty computer hobbyist, by using his computer to write words on a TV screen, can teach, preach and influence those around him. (It's fun and interesting too!) Sink your teeth into educational programs. Make them long or short, complex or simple, but use the information

in the article, and the accompanying glossary and checklist to make them effective and useful.

I would be pleased to work with anyone writing "teaching" or other educational computer programs. (What are the other kinds? You don't know? Go back and work the crossword puzzle again, please.) I am particularly interested in the various kinds of reinforcements that can be developed (color, graphics, etc.), but I'd be happy to help in the formulation of questions, layout of the material, etc. Please enclose SASE. There's room for lots of creative articles and programs in this field. ■

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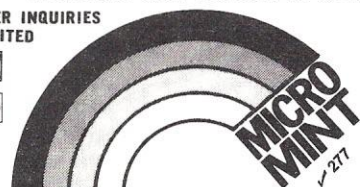
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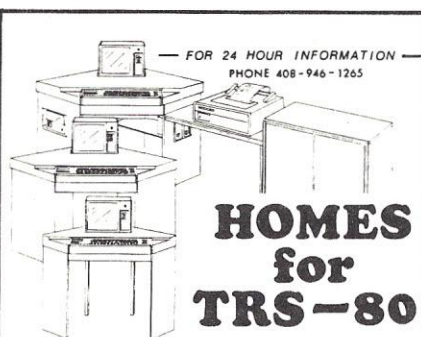
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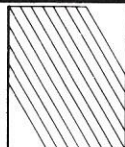
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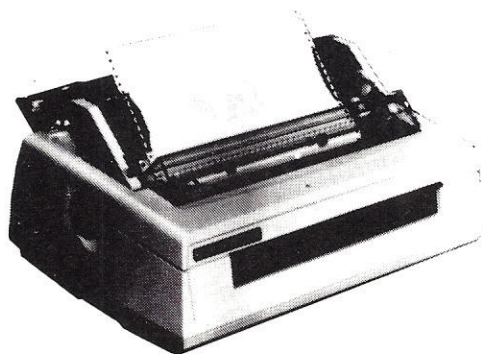
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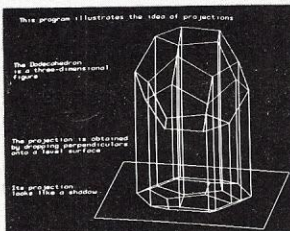
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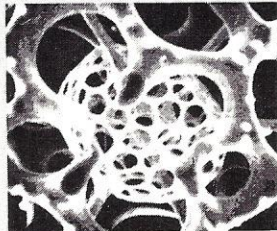
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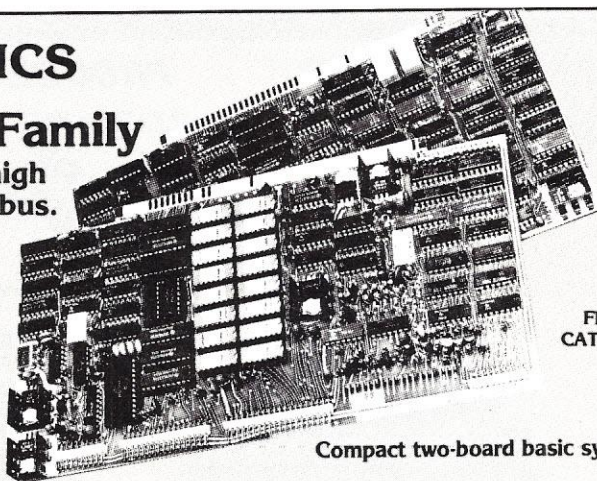


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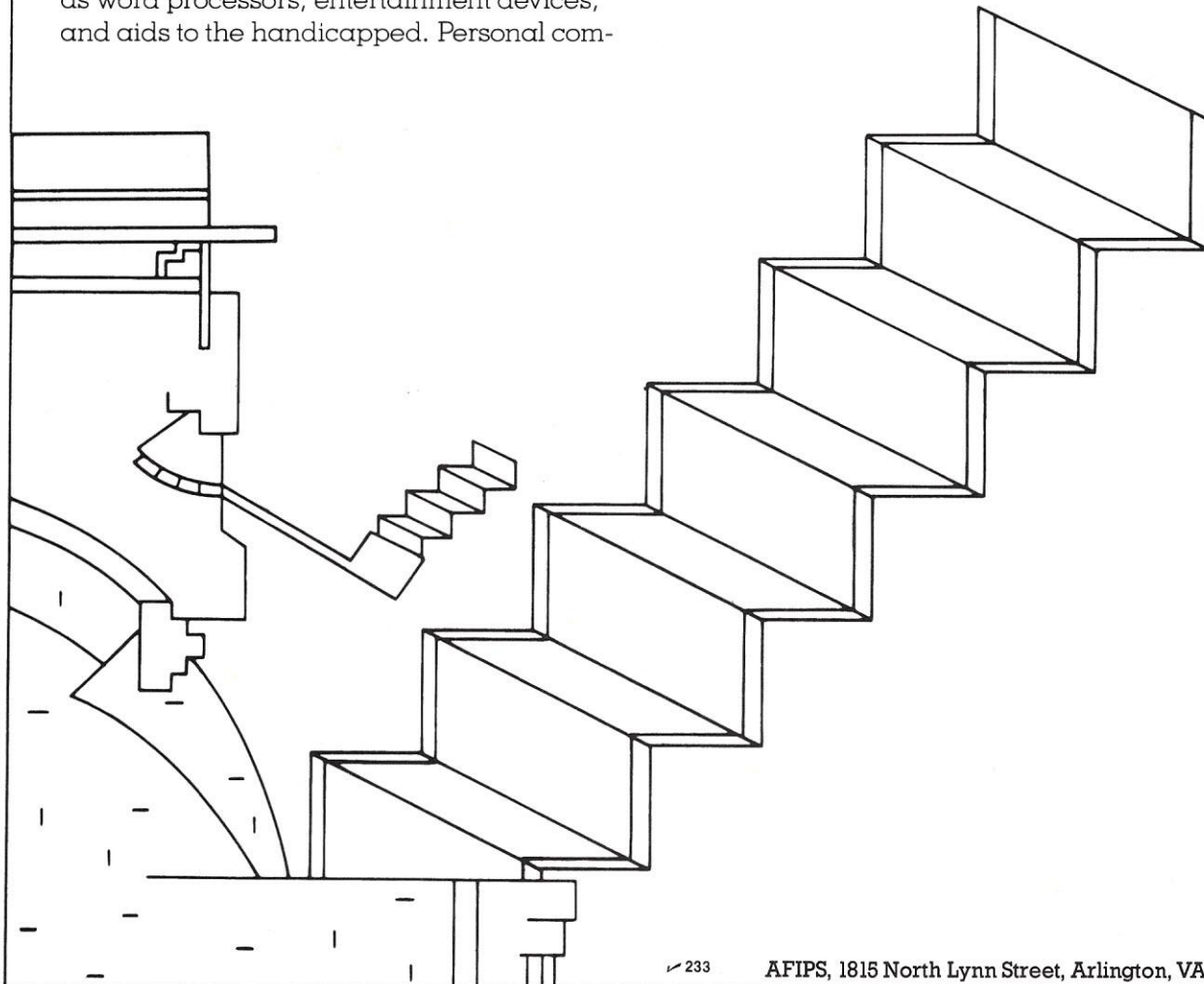
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# Tarbell Disk BASIC

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*BASICs abound. Here's a look at how this BASIC interpreter stacks up.*

---

Rod Hallen  
State Dept.-Accra  
Washington DC 20520

**T**here are almost as many different versions of BASIC as there are types of machines to run them on. While these variations contain most of the features of the original Dartmouth BASIC, each has been enhanced by the addition of features intended to make their use easier, faster or more versatile.

Many times, while creating a BASIC program, I have felt the need for some feature or other that would simplify my task. I'm sure that this is what motivates the originators of these enhancements. Of course, these improvements do not make for compatibility among BASICs.

Over the past three years I have used the following BASICs extensively, and my opinion of Tarbell Disk BASIC is based on that use: Processor Technology's BASIC5 and Extended Cassette BASIC, Radio Shack's Level I, Level II and DOS BASIC, Microsoft's Extended Disk BASIC and BASIC-E. All of these are interpreters, except BASIC-E, which is a compiler.

An interpreter evaluates each program line as it is encountered

and performs accordingly. A compiler compiles a program after it has been written, and the resultant compact machine code is actually used at RUN time. The compiled RUN code takes much less memory and runs faster than its interpreted counterpart. However, BASIC compilers are not very popular with computer hobbyists because they are much more difficult to write and debug programs with.

Since I felt that a combination interpreter/compiler would be an ideal programming tool, I tried writing and debugging programs with Microsoft or Tarbell BASIC and then compiling them with BASIC-E. This worked quite well with very simple programs, but it limited the use of the special features that each BASIC boasts about. What is needed are an interpreter and a compiler that both recognize exactly the same language.

## Tarbell Disk BASIC

With this experience and these thoughts in mind, let's look at Dave Tarbell's BASIC interpreter and see how it stacks up. The one I have is designed to run under the CP/M disk operating system, but there is also a cassette version.

In order to write programs in Tarbell BASIC, you must type

ENTER (or :), and from then on all entry is assumed to be program lines. A double carriage return terminates the Entry mode. Once a program is entered, it can be RUN, SAVED or EDITed. During your first few RUNs you will probably come up with some error messages, unless the program is very small or you're very careful. More than 40 different error messages are provided, and most are self-explanatory; a few are not.

This BASIC is very space conscious. If a space is not entered before and after each reserved word (FOR, TO, GOTO, THEN, etc.), an error message will be given. I am so used to entering lines continuously without spaces that I'm still having prob-

lems. One nice feature is that most error messages are displayed as soon as a line is entered. You don't have to wait until the entire program is entered and RUN to discover that you misspelled a statement, left out an equal sign (=) or made some other simple syntax error.

The first thing that you notice about a Tarbell program is the lack of line numbers. They are not required, and I don't feel that they are necessarily desirable. In place of line numbers, Tarbell uses line designators, which are alphanumeric strings. Also, line designators are not required for every line. You can still use line numbers if you like, but why do it when words are so much more meaningful?

## TYPE TEST

```
TEST      LET X=0:LET Y=5
          PRINT "ROD IS MY MASTER!"
          LET X=X+1
          IF X<>5 THEN GOTO TEST & 1
          PRINT
NAME      PRINT "MOST OF THE TIME!"
          LET Y=Y-1
          IF Y<>0 THEN GOTO NAME
          END
```

*Listing 1. Program written in Tarbell BASIC to show the use of line designators instead of line numbers. Note that GOTOs and GOSUBs refer to any line in the program by using a plus or minus offset from any line designator.*



## Operation

Listing 1 shows a simple program written to show how line designators are used. TEST and NAME are line designators. Note that GOTOs and GOSUBs can refer to a line designator or be offset plus or minus from one. GOTO TEST + 1 takes program control to the line immediately following the line designated TEST. The line designator NAME could have been left out, and then the next to the last line would read IF Y<>0 THEN GOTO TEST+5.

Listing 2 shows another interesting feature of Tarbell BASIC: variables can also be alphanumeric. X and Y of Listing 1 have been replaced with the variables FIRST and LAST. Using words instead of letters for variables makes a program more readable because, if appropriate names are chosen, it is easier to figure out what each variable is used for.

To make changes or corrections, the EDIT mode is entered. You do this by typing EDIT and a line designator for the line you want to edit. If you wanted to change the seventh line of Listing 2, you'd type EDIT NAME+1. That line would be displayed on the screen, and you'd have 19 single-letter commands to insert, delete, change, kill, append and more. I found the edit commands very difficult to use at first and messed up many programs until I became used to them. The major problem was that I am very familiar with the Microsoft editor and kept trying to use its commands.

Before and/or after editing oc-

curs, you can save your program on disk. There are two methods of doing this: SAVE puts the program on disk in ASCII format, and BSAVE records in binary. ASCII files can be read and printed using the CP/M DOS, while binary files cannot. The ASCII files can also be loaded into other BASICs such as Microsoft Disk BASIC. However, that doesn't necessarily mean they will run that way. That depends on whether or not you use noncompatible statements. The advantage of binary files is that they use less disk space and load more quickly than ASCII files.

Both sequential and random access data files, which can be either binary or ASCII, are also supported. The manual doesn't go too deeply into the explanation of data files, and I haven't done a lot with them, but they appear to be much easier to handle than Microsoft's. An example inventory program that uses random access data files is given. While no documentation accompanies it, the alphanumeric line designators and variable names make it easier to read and understand.

For users interested in the mathematical aspects, the following information is given: the range of an integer number is from 0 to 9999999999 plus or minus, and the range of a floating-point number is from 9.999999999E+99 to 9.999999999E-99. Numbers are handled in ten-digit BCD form.

## Unique Features

Table 1 lists some of the features of Tarbell BASIC that are

not available in most other BASICs. Most of these are useful and well thought out. Some of them merit additional discussion.

CHANNEL, ASSIGN and DROP are part of a flexible I/O handling scheme. Up to eight logical devices and ten physical devices are supported, and their assignments can be changed at will. Each time that the CHANNEL command is entered, a map of the current I/O assignment is displayed. Table 2 shows the normal display.

The ASSIGN and DROP commands are used to change assignments. For instance, if I wanted to send output to the list device, ASSIGN 1,5 would accomplish it. Output would also continue to go to the screen. DROP 1,2 would stop screen display. ASSIGN 1,2:DROP 1,5 would shift output back to the screen.

Local variables not affected by main program operation are allowed within subroutines through the use of the GOPROC, PROCEDURE and RECEIVE statements. Variables can be passed to subroutines for local

use, but they are unchanged upon return to the main program. This is a little difficult to explain, and the manual does not go into great detail on the subject. In fact, the rather thin manual does little more than give a limited explanation on any of the statements and commands, but it does recommend some good BASIC textbooks.

The RESTORE statement can be suffixed with a line designator so that the DATA pointer is set to any desired list of data. Most BASICs will only restore to the first DATA statement in the program. I have found this to be useful while using PT's Extended Cassette BASIC.

OCT, OCT\$, HEX and HEX\$ are used to convert from octal or hex to decimal or vice versa. MATCH will hunt through one string for the first occurrence of a second string, and SEARCH will look through a disk file for a given string.

Strong assembly-language linking commands are provided to allow the use of machine code in conjunction with BASIC programs. USR calls a machine-code subroutine with a two-byte

```
A>TYPE TEST1
TEST   LET FIRST=0:LET LAST=5
        PRINT "ROD IS MY MASTER!"
        LET FIRST=FIRST+1
        IF FIRST<>5 THEN GOTO TEST & 1
NAME   PRINT "MOST OF THE TIME!"
        LET LAST=LAST-1
        IF LAST<>0 THEN GOTO NAME
END
```

Listing 2. Program of Listing 1 rewritten to show how words can be used in place of one- or two-letter variables to make a program more readable.

| Statement | Purpose  |
|-----------|--|
| APPEND    | Add additional program to one or more already in memory                          |
| ASSIGN    | Assigns a physical device to a logical device                                    |
| CHANNEL   | Displays the logical-physical device map   |
| CHECK     | Verify a program or file from the disk without actually loading it               |
| DIR       | List disk directory  |
| DROP      | Delete logical-physical device connection  |
| GOPROC    | GOTO using local variables   |
| KILL      | Delete given variable from a program   |
| MOVEBOF   | Moves to beginning of selected disk data file                                    |
| MOVEEOF   | Moves to end of selected disk data file  |
| PROCEDURE | Used to declare local variables  |
| RECEIVE   | Returns local variables  |
| RENAME    | Changes the name of a disk file  |
| SYMBOL    | List all program variables and their addresses                                   |
| WAIT      | Reads a given input port with a specified mask until a nonzero condition results |
| WIDTH     | Sets line width on screen or printer   |

| Function  | Purpose   |
|-----------|---|
| CALL      | Calls a machine-language subroutine               |
| EOF       | Determines if the end of a file has been reached  |
| FILEXISTS | Determines if a stated file exists on a disk      |
| FRE       | Returns the amount of free memory space           |
| HEX       | Returns the decimal equivalent of a hex number    |
| HEX\$     | Returns the hex equivalent of a decimal number    |
| LOC       | Returns the decimal address of a stated variable  |
| MATCH     | Returns the position of one string within another |
| OCT       | Returns the decimal equivalent of an octal number |
| OCT\$     | Returns the octal equivalent of a decimal number  |
| POS       | Returns the current position of the printer       |
| SEARCH    | Look through a disk file for a given string       |
| SPC       | Prints given number of spaces on the printer      |

Table 1. Features of Tarbell BASIC not available in most other BASIC interpreters.



| Logical device number |   | Physical device number |   | CHANNELS        |                 |
|-----------------------|---|------------------------|---|-----------------|-----------------|
|                       |   |                        |   | PHYSICAL        | LOGICAL DEVICES |
| INPUT                 | 0 | Keyboard               | 0 | 0.....          | X . . . . .     |
| OUTPUT                | 1 | Screen                 | 1 | 1.....          | . X . . . . .   |
| LOAD                  | 2 | Cassette in            | 2 | 2.....          | . . . . .       |
| SAVE                  | 3 | Cassette out           | 3 | 3.....          | . . . . .       |
| BLOAD                 | 4 | Spare                  | 4 | 4.....          | . . . . .       |
| BSAVE                 | 5 | Printer                | 5 | 5.....          | . X . . . . .   |
| SPARE                 | 6 | Reader                 | 6 | 6.....          | . . . . .       |
| SPARE                 | 7 | Punch                  | 7 | 7.....          | . . . . .       |
|                       |   | Disk in                | 8 | 8.....          | . . X . X . .   |
|                       |   | Disk out               | 9 | 9.....          | . . . X . X .   |
|                       |   |                        |   | 0 1 2 3 4 5 6 7 |                 |

Table 2. Logical and physical I/O device assignments and the map that is displayed and controlled through the use of the CHANNEL, ASSIGN and DROP commands. Input is from the keyboard; output is to the screen and printer; and all save and load operations are via the disk.

variable in register pair D-E; LOC returns the decimal address where a designated BASIC variable is stored; SYMBOL lists all program variables and their storage addresses; and a Tarbell BASIC memory map is provided in the manual so that the assembly-language programmer knows where to look for various information he might need while linking BASIC and machine code.

For those of you who still desire line-numbered programs, an auto number feature is provided. No renumber command is provided and needed since program progression proceeds in the order that the lines are entered and not necessarily in numerical order. In other words, line numbers are used like line designators, and their actual numerical value is meaningless.

APPEND is designed to load one program at the end of a previously loaded one. This can continue as long as you have memory space available. However, you have to be sure that none of the programs that are tied together in this manner utilize similar line designators. This would cause the same problems that loading two programs with the same line numbers would.

#### Limitations

I did run into a few problems that appear to be program bugs. DIR gives a listing of all of the files on the current disk. However, it would not work after certain types of error messages had been displayed or the ASSIGN command was used unless a CLEAR command, which would never come up on the

LIST device, was given.

I earlier discussed the ability of Tarbell BASIC to save and load disk files in either ASCII or binary. This ability can result in problems unless it is used properly. Programs or files that are SAVED in ASCII must be LOADED in ASCII; those BSAVED in binary must be BLOADED in binary. If you attempt to LOAD a binary program, an error message will appear and you can correct your mistake. But if you try to BLOAD an ASCII program, an out-of-memory error will result and BASIC will hang up. I find it necessary to reset the microprocessor when this occurs. A practical solution seems to be to name files so that their format is evident or to use only one format in all cases.

No PRINT USING function is provided, and the manual states

that subroutines using local variables are easily written to take care of this. No information on how this is accomplished is given.

The final problem relates to the EDIT mode. Many times a program will give error messages after it has been edited, even though it appears to be correct. Completely retyping the offending area of the program banishes the error message but doesn't give any indication as to what the problem was. Apparently something remains in the program but isn't displayed on the screen.

#### Conclusions

Tarbell BASIC, which is available from Tarbell Electronics, 950 Dovlen Place, Suite B, Carson CA 90746, has a lot going for it. In addition to all of the features discussed above and listed in Table 1, it will recognize most of the commands, statements and functions of the various versions of Mits and Microsoft BASIC.

And the price is right. It sells for \$48, which is one-seventh of the cost of Microsoft Extended Disk BASIC. For all of you software tinkerers, the source is available on disk or paper tape for \$25. All of this makes it one of the most versatile and least expensive CP/M-compatible disk BASIC interpreters on the market. ■

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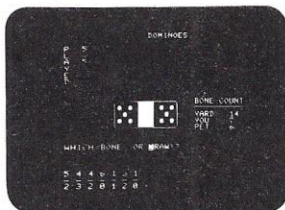




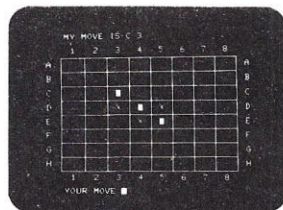
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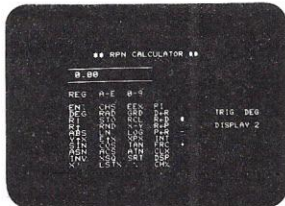
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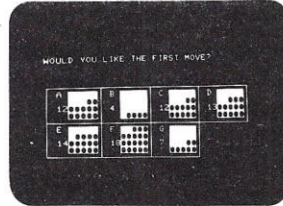
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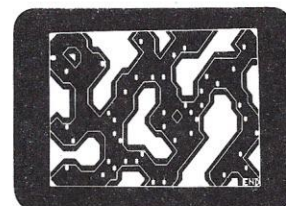
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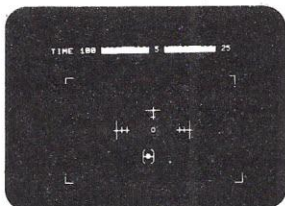
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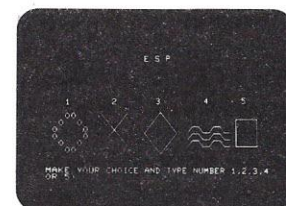
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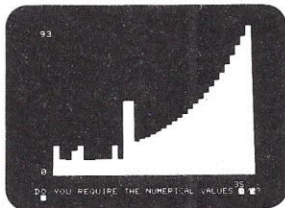
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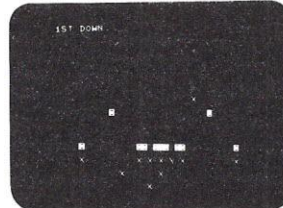
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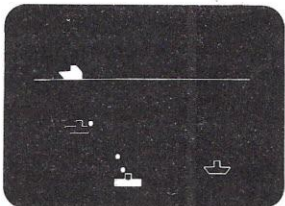
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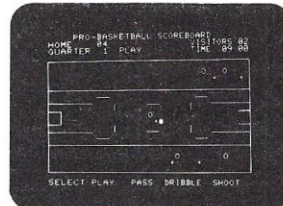
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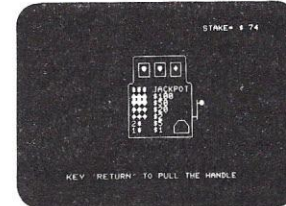
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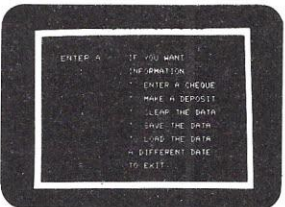
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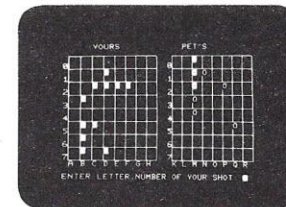
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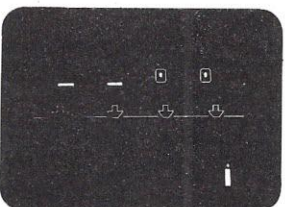
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# Micromonitor for MIKBUG

*An editor/assembler may be more than you need; try this 159-byte helper instead.*

David L. Tietz  
Route 3, 21 Rainetta Dr.  
Eau Claire WI 54701

Here's a routine I've found helpful when I'm using my SWTP 6800. I have an ASR 33 TTY and mostly do machine-language programming.

When I first brought up my 6800, it took about three minutes to realize there had to be a faster, easier method of dealing with memory than MIKBUG's slow load and examine format. Waiting the 15, or so, minutes it would take my reader to crank in an Editor/Assembler was not my idea of a choice. Also the possibility of having one of my programs go astray and modify the Editor/Assembler once it was in left me in a cold sweat.

Thus I was prompted to write Micromonitor. It's a compromise routine that loads up through my reader in about 50 seconds. The program occupies 159 bytes and is relocatable anywhere without change.

I have it located near the top of memory (2F50<sub>H</sub>-2FEE<sub>H</sub>) in my 12K system. The program could be used in a system with as little as ½K and be practical. Micromonitor uses memory locations 0000<sub>H</sub> through 0003<sub>H</sub> as scratchpad for temporary data storage. It is expandable (through the subroutine feature listed below) and does depend on MIKBUG's being present.

Let me list the main features, then I'll show you how to use it with the program example I have included.

## Program Features

**Memory Load:** Allows bytes to be entered directly into memory with error correction and address display upon demand.

**Memory Display:** Prints contents of memory in lines 16 bytes long with an address at the start of each line. I've found this 16-byte format to be a big assist in computing branches.

**Go-To-Subroutine-And-Back:** Allows testing of subroutines and provides a method of adding features to Micromonitor.

**Go-To-User's-Program:** Loads up MIKBUG's program

counter (memory locations A048<sub>H</sub> and A049<sub>H</sub>) immediately without going through MIKBUG.

## How to Use the Program

Fig. 1 shows a program entry through Micromonitor. The as-

terisk, L, is where I loaded Micromonitor through the reader using MIKBUG. A048<sub>H</sub> and A049<sub>H</sub> were then loaded with Micromonitor's starting address, G was typed and Micromonitor prompted with CR, LF and @. I typed the address to be

```
*L
*M A048
*A048 70 2F
*A049 3E 50
*A04A 6C
*G
#0100 L
0100 BD 2F 71 CE 01 40 BD E1 AC 81 0D 27 05 A7 00 08 20 F4
0112 86 20 A7 00 86 4F <
0117 42 A7 01 86 4F A7 02 A7 04 9<86 5A A7 03 86 04 A7 05
0128 BD 2F 71 BD 01 36 CE 01 40 BD E0 7E 20 CA CE FF FF
0139 09 01 01 01 20 <
013F 26 FA 39
0140 #
#0100 013F
0100 BD 2F 71 CE 01 40 BD E1 AC 81 0D 27 05 A7 00 08
0110 20 F4 86 20 A7 00 86 42 A7 01 86 4F A7 02 A7 04
0120 86 5A A7 03 86 04 A7 05 BD 2F 71 BD 01 36 CE 01
0130 40 BD E0 7E 20 CA CE FF FF 09 01 01 01 26 FA 39
#0136 S
#0100 G
HELLO
HELLO #020
*
```

Fig. 1.

Fig. 2.

```
00010      NAM      MICR      MON
00020      *MICRO MONITOR
00030      *ENHANCEMENT TO MIKBUG
00040      *PROVIDES FAST LOAD, DISPLAY, GO AND
00050      *SUBROUTINE TEST
00060      *WRITTEN BY DAVE TIETZ
00070      OPT      0,5
00080      A041      STACK EQU $A041
00090      EOCA      OUT2HS EQU $EOCA
00100      EOCA      OUT4HS EQU $EOCA
00110      E1D1      OUTEEE EQU $E1D1
00120      E1AC      INEEE EQU $E1AC
00130      E10F      MIKGO EQU $E10F
00140      EO47      BADDR EQU $EO47
00150      A048      PC EQU $A048
00160      *
00170 2F50      *      ORG      $2F50
00180      *
00190      *INITIALIZE
00200      *
00210 2F50 8E A041      LDS      #STACK
00220 2F53 8D 1C      START BSR      CRLF
00230 2F55 86 40      LDA A      $S40
00240 2F57 8D 2C      BSR      OUTEM      DISPLAY CR, LF, "0"
00250      *
00260      *CALL ADDRESS AND COMMAND
00270      *
00280 2F59 8D 25      BSR      BADDRM      BUILD ADDRESS
00290 2F5B 8D 2B      BSR      INEEM      CALL COMMAND
00300 2F5D 81 4C      CMP A      $S4C      IS IT A "L"?
00310 2F5F 27 50      BEQ      LOAD
00320 2F61 81 20      CMP A      $S20      IS IT A " "?
00330 2F63 27 2C      BEQ      DISP
00340 2F65 81 47      CMP A      $S47      IS IT A "G"?
00350 2F67 27 22      BEQ      GO
00360 2F69 81 53      CMP A      $S53      IS IT A "S"?
00370 2F6B 26 E6      BNE      START      RESTART ON DEFAULT
00380      *
00390      *SUBROUTINE TEST
00400      *
00410 2F6D AD 00      JSR      00,X      JMP TO USER'S SUBROUTINE
00420 2F6F 20 E2      BRA      START      USER SUBROUTINE DONE, RESTART
00430      *
00440      *SUBROUTINES
00450      *
00460 2F71 86 0D      CHLF      LDA A      $S0D      OUTPUT CARRIAGE RETURN
00470 2F73 8D 10      BSR      OUTEM
00480 2F75 86 0A      LDA A      $S0A
00490 2F77 8D 0C      BSR      OUTEM      OUTPUT LINE FEED
00500 2F79 8D 00      BSR      NULL2      OUTPUT 4 NULLS
00510 2F7B 4F      NULL2      CLK A
00520 2F7C 8D 07      BSR      OUTEM
00530 2F7E 20 05      BRA      OUTEM      OUTPUT TWO NULLS AND RIS
00540 2F80 BD E047      BADDRM      JSR      BADDR      BUILD ADDRESS IN ICR
00550 2F83 86 20      SPOUT      LDA A      $S20
00560 2F85 7E E1D1      OUTEM      JMP      OUTEEE      OUTPUT CHARACTER IN ACC A
00570 2F88 7E E1AC      INEEM      JMP      INEEE      CALL CHARACTER FROM TERMINAL
00580      *
00590      *GO TO USER PROGRAM
00600      *
00610 2F8B FF A048      GO      STX      PC      LOAD MIKBUG PROGRAM COUNTER
00620 2F8E 7E E10F      JMP      MIKGO      JMP TO MIKBUG'S GO
00630      *
00640      *DISPLAY MEMORY CONTENTS
00650      *
00660 2F91 DF 00      DISP      STX      $00      SAVE STARTING ADDR
00670 2F93 8D EB      BSR      BADDRM      GET END ADDR
00680 2F95 08      INX
00690 2F96 DF 02      STX      $02      ADD 1 FOR TEST
00700 2F98 DE 00      LDX
00710 2F9A 8D 38      NEWLIN      BSR      ECHO      SAVE END ADDR
00720 2F9C C6 11      LDA B      $S11      RESTORE START ADDR
00730 2F9E 5A      AGAIN      DEC B      ECHO ADDR ON NEW LINE
                                SET BYTE COUNT TO 17(BASE 10)
```



loaded, Micromonitor inserted a space and I typed the L. Micromonitor echoed that address on the next line followed by two spaces. Then I typed code in with Micromonitor inserting the spaces between the bytes. After I filled a line, I hit return, and Micromonitor gave the TTY a CR, LF and printed the next address to be loaded (hitting return after any byte entry displays the address of the next byte to be loaded).

Notice that I made some mistakes (for illustration only, of course), and typing < after either a nibble or byte backs up Micromonitor to allow reentry of the data. The < after a byte entry echoes the current mem-

ory location to be loaded on the next line; after a nibble, it just continues with the correct byte entry.

When entering the program, I hit carriage return to get the address echo (so I would know program length). After I typed @, which returned me to Micromonitor, I entered the starting address of my program, a space and the ending address. Micromonitor gave me the listing shown in Fig. 1 (free of the <s and teardrops I always have on the paper during program entry).

Notice that the address of the first byte is printed, then eight bytes, and extra space and eight more bytes. If your

listings start at XXX0H memory location (per the example), the extra space is between XXX7H and XXX8H and saves some counting to identify bytes. Micromonitor gives a complete listing up to and including the byte at the ending address.

After Micromonitor gave me the listing, it again prompted with @. The program has a time delay subroutine located at memory location 0136H. I tried it by entering the subroutine's address, followed by an S. The subroutine ran and Micromonitor returned again.

Finally, I ran the complete program. After getting Micromonitor's @, I typed the starting address of the program and then G. This loaded A048H and A049H and executed the MIKBUG GO. The program ran, and I hit reset to return to MIKBUG. Now, if I want to get back to Micromonitor, I must use MIKBUG to reload A048H and A049H with Micromonitor's starting address and type G.

## Concluding Comments

Fig. 2 is a listing of Micromonitor with my comments. The very top bytes of memory have been reserved for any patches I may wish to put in. I chose not to have Micromonitor test for valid hex numbers while loading. If you wish, the MKHEX subroutine could be expanded to test for hex numbers similar to MIKBUG's INHEX subroutine (it takes ten extra bytes).

Because Micromonitor is in MIKBUG's BADDR subroutine after its prompt, typing any non-hex character after the @ will patch you to MIKBUG, and if the program counter isn't changed, typing G after MIKBUG's \* will run Micromonitor.

I have used Micromonitor as my main programming monitor for over a year. Even now that I have an Editor/Assembler running on my system, I find numerous occasions to use it. It's still faster than my assembler for memory dumps and quick program patches. ■

```

00740 2F9F 27 F9      BEQ    NEWLIN    PRINTED 16 BYTES, DO NEW LINE
00750 2FA1 C1 08      CMP B  #508     PRINTED 8 BYTES?
00760 2FA3 26 02      BNE    ON       NOPE, KEEP GOING
00770 2FA5 8D DC      BSR    SPOUT     YUP, INSET SPACE
00780 2FA7 BD E0CA ON  JSR    OUT2HS    OUTPUT BYTE TO TERMINAL
00790 2FAA 9C 02      CPX    #02       IXR = END ADDR?
00800 2FAC 26 F0      BNE    AGAIN    NO, DO AGAIN
00810 2FAE 20 A3      BRA    START     DONE, RESTART
00820
00830      *LOAD MEMORY
00840
00850 2FB0 09          *BACKUP DEX      MOVE BACK ONE MEM LOC
00860 2FB1 8D 21      LOAD BSR      ECHO    ECHO MEM LOC ON NEW LINE
00870 2FB3 8D 03      CALL BSR      INHEM    CALL 1ST NIBBLE
00880 2FB5 81 3C      CMP A  #33C     IS IT "c"?
00890 2FB7 27 F7      BEQ    BACKUP    BACK UP ONE LOCATION
00900 2FB9 81 0D      CMP A  #50D     IS IT "CR"?
00910 2FBB 27 F4      BEQ    LOAD      START NEW LINE
00920 2FBD 81 40      CMP A  #540     IS IT "a"?
00930 2FBF 27 92      BEQ    START
00940 2FC1 8D 1F      BSR    MKHEX    TEST FOR "<", CONVERT ASCII
00950 2FC3 48          ASL A          MOVE
00960 2FC4 48          ASL A          MASKED ASCII
00970 2FC5 48          ASL A          TO MOST
00980 2FC6 48          ASL A          SIGNIFICANT NIBBLE
00990 2FC7 16          TAB
01000 2FC8 8D BE      BSR    INHEM    CALL 2ND NIBBLE
01010 2FCA 8D 16      BSR    MKHEX    TEST AND CONVERT
01020 2FCC 1B          ABA
01030 2FCD A7 00      STA A 00,X      ADD TWO NIBBLES
01040 2FCF 08          INX
01050 2FD0 8D B1      BSR    SPOUT     LOAD MEM LOC
01060 2FD2 20 DF      BRA CALL        POINT TO NEXT
01070 2FDA 8D 9B      BSR    CRLF      INSERT A SPACE
01080 2FDE DF 00      STX    $00      GET NEXT BYTE
01090 2FD8 CE 0000    LDX    #50000    IXR TO MEMORY
01100 2FDB BD E0C9    JSR    OUT4HS    POINT TO MEMORY
01110 2FDE DE 00      LDX    $00      DISPLAY IXR CONTENTS
01120 2FE0 20 A1      BRA SPOUT
01130 2FE2 81 3C      CMP A  #33C     OUTPUT SPACE AND RTS
01140 2FE4 27 CD      BEQ    CALL      IS IT A "c"?
01150 2FE6 80 30      SUB A  #330     YUP, IGNORE 1ST NIBBLE
01160 2FE8 81 09      CMP A  #509     IS IT NUMBER?
01170 2FEA 2F 02      BLE    OUT
01180 2FEC 80 07      SUB A  #507     ASSUME IT'S A LETTER
01190 2FEE 39          OUT    RTS
01200      END
STACK A041
OUT2HS E0CA
OUT4HS E0C8
OUTEEE E1D1
INEEE E1AC
MIKGO E10F
BADDR E047
PC A048
START 2F53
CRLF 2F71
NULL2 2F7B
BADDRM 2F80
SPOUT 2F83
OUTEM 2F85
INEEM 2F88
GO 2F8B
DISP 2F91
NEWLIN 2F9A
AGAIN 2F9E
ON 2FA7
BACKUP 2FB0
LOAD 2FB1
CALL 2FB3
ECHO 2FD4
MKHEX 2FE2
OUT 2FEE
TOTAL ERRORS 00000

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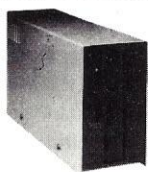


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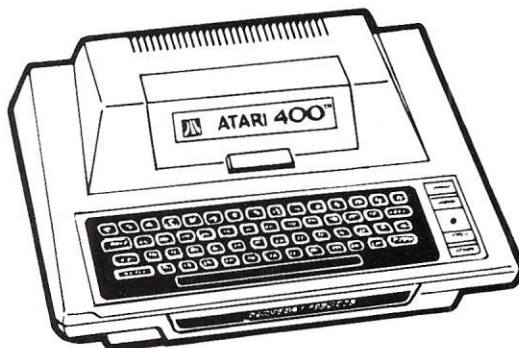
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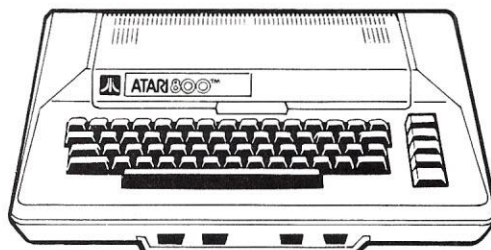


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# DATECK

## *A program subroutine for date checking and formatting.*

J. Tom Badgett  
400 Albemarle Street  
Bluefield WV 24701

One of my pet peeves is a computer program that requires the operator to remember important details about entering data from the keyboard. This kind of programming is time consuming and wasteful of the very features that make a computer useful in the first place. Moreover, it can lead to improper data entry.

For example, consider the date entered as part of a business program. The software may use this information

for aging of accounts, checking records for proper sequence of data entry and the like. Many programs, however, depend on the operator to give the computer a proper date to work with. Some will even accept absolute garbage in the date-entry routine.

### Entering Dates

Many programmers, for example, use a single string to enter the date for a given program run. The input statement for this type of date entry might be of the form:

```
10 INPUT "ENTER TODAY'S DATE";D$
```

The operator then enters the date in whatever form he de-

sires: 11/20/78, 11,20,78, or 20 November 1978. He might also enter an invalid date—that is, accidentally enter 32 days in a month. With a single string for input he might even enter complete garbage, either accidentally or maliciously. The computer doesn't care what you type in response to the sample input statement above. It simply is looking for some value for D\$.

Here's a short, simple date-entry routine that I now use on all my programs requiring date entry from the keyboard. This routine accepts the date in three separate strings: one for the month, another for the day and a third for the year. Most people seem to expect to enter the date as a series of numbers in the form: 11,20,78. By using three separate entries, you make it easier for the computer to inspect the date you've entered to determine its validity.

I use string entry instead of numerical input because it gives me more versatility in programming. I can make several checks on the strings entered (see Program 1) to cause the program to do a variety of things instead of what it would do normally. Also, you can use this string versatility to format the date input however is convenient. See Program 2 for alternate date-entry scheme uses. You can use this MID\$ search routine to look for any type of special character in any string. It is a useful BASIC command to help install program "checks."

### The Program

Now, refer to Program 3 for the following discussion. The line numbers start at 40000 be-

cause I want to use it as a subroutine in many of my programs. That way I can load it into workspace from disk or cassette before I start to write a program and don't have to key it in every time.

Lines 40000-40002 simply help me remember what this particular subroutine does. If you can afford the memory, always document your software in some manner.

Lines 40010-40040 set up a matrix containing the months of the year. The routine uses this information to print out the date for checking in the form: 20/NOVEMBER/78. I prefer this format when the date is to be part of the printed output of a program.

Lines 40050-40060 contain more documentation to help me use the subroutine. After several months without using a particular piece of software I sometimes forget how to use it. In this case, if you forget to dimension the variable M\$, your computer will likely return an error because most BASICs limit the size of a matrix to 10 unless you tell the computer otherwise.

Lines 40065-40070 accept the date information from the keyboard. Various checks are performed on the input data in lines 40080-40120. If you enter either the month or the day as a number less than 1, the program will go to line 40800 to print an error message and ask for the information again. Similarly, if the number of days in the month is over 31, the computer will spot the error and require reentry of the data. If the operator attempts to input more than two numbers for the year, the program will perceive this as an error and go to

```
10 INPUT "PLEASE ENTER TODAY'S DATE ";D$.D1$.Y$
20 IF D$="MENU" THEN 100
30 IF D$="X" THEN CLOSE: END
40 IF D$="HELP" THEN 1000 : REM PROGRAM INSTRUCTIONS
50 IF D$="BYE" THEN CLOSE: RUN"COMMND
60 <<<Continue with as many similar checks as necessary, then
   go on with the main part of the program>>>
```

### Program 1.

```
RUN
ENTER TODAY'S DATE (M,D,Y) ? 11,31,78
DATE INVALID--PLEASE REENTER (M,D,Y): : : ? 11,20,78
      20/NOVEMBER/78.
IS DATE OK ( Y OR NO ) : : : ? Y
?RG ERROR IN 40220
OK

RUN
ENTER TODAY'S DATE (M,D,Y) ? 2,29,78
IS THIS A LEAP YEAR ( Y OR N ) ? N
DATE INVALID--PLEASE REENTER (M,D,Y): : : ? 2,28,78
      28/FEBRUARY/78.
IS DATE OK ( Y OR NO ) : : : ? Y
?RG ERROR IN 40220
OK
```

*Sample run. The computer requires reentry when invalid dates—November 31 and February 29, 1978—are entered. RG ERROR IN 40220 means the computer didn't know where to go after the RETURN statement.*



```

5 DIM D$(17)
10 INPUT "ENTER TODAY'S DATE (MM/DD/YY) ":D$
12 FL=0
15 A=0
20 FOR J=1 TO 17
30 D$(J)=MID$(D$,J,1)
35 X=X+1
40 IF D$(J)="/" THEN 100
60 NEXT J
100 FOR I=A+1 TO X-1
110 DATE$=DATE$+D$(I)
120 NEXT I
125 GOSUB 40000
130 A=X
140 FOR J=X+1 TO 17
145 IF FL=3 THEN END
150 GOTO 30
40000 PRINT "DATE$=";DATE$
40002 FL=FL+1
40005 PRINT:DATE$=""
40010 RETURN
OK

```

```

RUN
ENTER TODAY'S DATE (MM/DD/YY) ? 11/20/78
DATE$= 11

DATE$= 20
DATE$= 78

OK

RUN
ENTER TODAY'S DATE (MM/DD/YY) ? 20/NOVEMBER/1978
DATE$= 20

DATE$= NOVEMBER
DATE$= 1978

OK

```

Program 2. Alternate date-entry schemes.

line 40800.

At line 40130 the string for the month is converted to a number for easier manipulation, then several more checks are performed at lines 40140 and 40150. If the 4th, 6th, 9th or 11th months (months with only 30 days) are entered, the subroutine at line 41500 will check to make sure no more than 30 days have been entered for the date in that month. If the date is in February (D=2) and more than 28 days are entered, the program will go to line 42000 to determine if this is a leap year. If it is not a leap year then the date will be invalid and must be reentered.

Finally, the entered date is printed and the operator is asked to verify it. If it is OK then the program will return to the main program via the RETURN statement in line 40220. If the date needs to be changed at this point this program will go to line 40065 for the date to be reentered.

Note that another simple, but very important, type of data check is made in lines 40220

and 40230. Without line 40230 the program would function OK as long as the operator entered the expected "Y" or "N," "YES" or "NO."

Suppose something else

were entered? The program would "fall through" to line 40240 and go to the head of the program for reentry of the date, even if this were not what the operator intended. In this example little harm would be done, but suppose the asked-for input were a complicated formula or important financial information? An accidental entry of the wrong letter would dump the data and require re-entry—perhaps compounding the possibility of an error occurring the second time.

### Program Use

Program 2 uses the MID\$ BASIC command to search a string for certain limiters or identifiers. In this case I've used "/" as the limiter. A loop is set up in line 20 for a maximum of 17 characters (the maximum number likely with a date). The command in line 30 looks at each character in D\$, one by one.

In line 40, when the "/" is found, the program leaves the loop and goes to line 100. There another loop is established to build a new string, DATE\$. This string consists of all the numbers or letters from the beginning of D\$ to, but not including, the first "/."

In this example I've included

a print statement at line 40000 to show how the string is built, but normally this is where a routine similar to the one in Program 3 resides. After checking the first entry, this program returns to look at the rest of the string. The loop is reset at line 140 to pick up where the last one left off (i.e., after the first "/"), and it searches for the next limiter, and so on. In this way various date-entry routines can be used, checking each segment—day, month and year—for validity. The slight advantage of this arrangement is that the date, including the name of the month in whatever form is convenient, may be entered as long as the limiter "/" is properly placed.

### Conclusion

Whenever possible catch all possible situations with software before a serious program or bookkeeping mistake occurs. This little date-checking routine is just one example. Give serious considerations to all programs that require operator input and make sure there are "catches" in your software to handle careless data entry. Such precautions during the programming stage make your computer easier and more reliable to use. ■

```

40000 REM -----
40001 REM      Check/Format Date Subroutine
40002 REM -----
40010 M$(1)="JANUARY":M$(2)="FEBRUARY":M$(3)="MARCH":M$(4)="APRIL"
40020 M$(5)="MAY":M$(6)="JUNE":M$(7)="JULY":M$(8)="AUGUST"
40030 M$(9)="SEPTEMBER":M$(10)="OCTOBER":M$(11)="NOVEMBER"
40040 M$(12)="DECEMBER"
40050 REM ***** Be sure to dimension M$ to 12 at head of Program.
40055 REM ***** Most BASICs automatically limit variables to 10
40060 REM ***** without additional dimensioning.
40065 PRINT:PRINT "ENTER TODAY'S DATE (M,D,Y) ":
40070 INPUT D$, D1$, Y$
40080 IF LEN(Y$)<>2 THEN GOSUB 40800:GOTO 40070
40090 IF VAL(D$)>12 THEN GOSUB 40800:GOTO 40070
40100 IF VAL(D$)<1 THEN GOSUB 40800:GOTO 40070
40110 IF VAL(D1$)>31 THEN GOSUB 40800:GOTO 40070
40120 IF VAL(D1$)<1 THEN GOSUB 40800:GOTO 40070
40130 D=VAL(D$)
40140 IF D=4 OR D=6 OR D=9 OR D=11 THEN 41500
40150 IF D=2 AND VAL(D1$)>28 THEN 42000
40160 DATE$=D$+"/" + M$(D) + "/" + Y$
40200 PRINT:PRINT "      DATE$=";DATE$;
40210 INPUT "IS DATE OK ( Y OR NO ) :";Z$
40220 IF LEFT$(Z$,1)="Y" THEN RETURN
40230 IF LEFT$(Z$,1)(">"N" THEN 40200
40240 GOTO 40065
40800 PRINT:PRINT "DATE INVALID--PLEASE REENTER (M,D,Y) : : : ";
40820 RETURN
41500 IF VAL(D1$)<31 THEN 40150
41510 GOSUB 40800:GOTO 40070
42000 PRINT:PRINT "IS THIS A LEAP YEAR ( Y OR N ) ";L$
42010 IF LEFT$(L$,1)="Y" THEN 40160
42020 IF LEFT$(L$,1)(">"N" THEN 42000
42030 GOSUB 40800:GOTO 40070
OK

```

Program 3.



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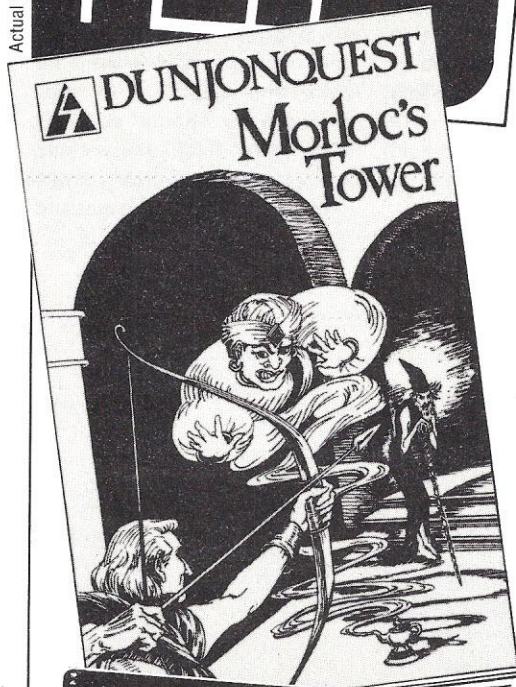
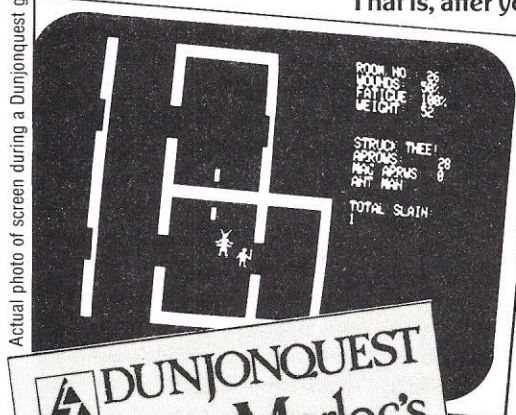
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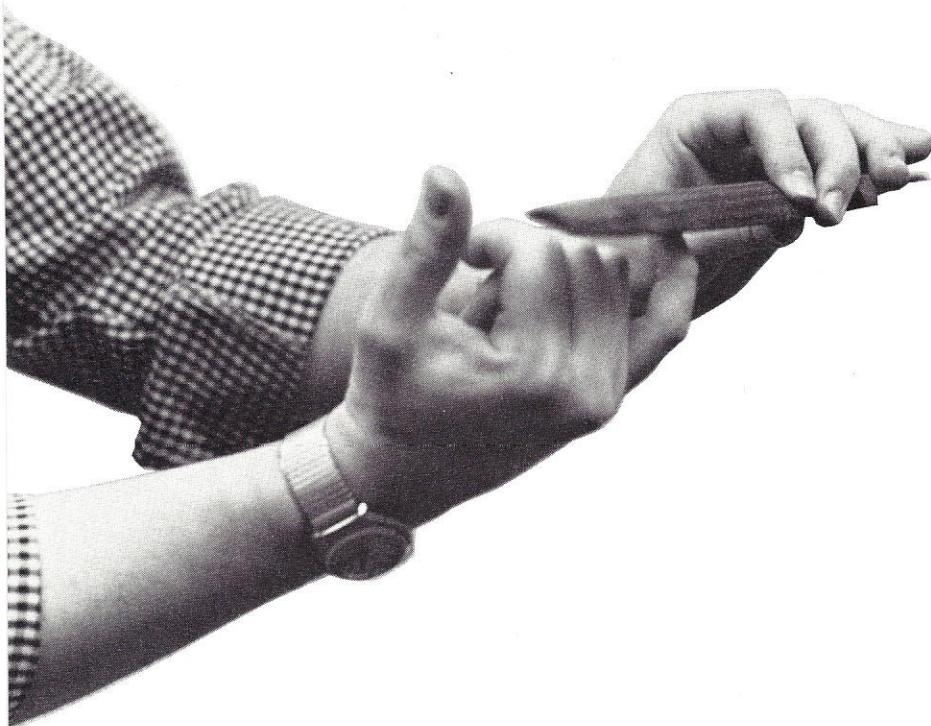
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# FILEIT

*Last month, we had, as you might say, a "screening" of this program.*

Forest E. Myers  
5114 Garnett St.  
Shawnee KS 66203

If you have had a chance to implement my SCREEN program in last month's issue, you are probably waiting to implement its complement program, FILEIT. As you will recall, the

purpose of SCREEN was to create a data entry screen to be used by FILEIT, a program to create and manipulate a data base. Although the task of bringing FILEIT up on your system will be somewhat more difficult than with SCREEN, the task is not insurmountable, and the rewards for doing so are con-

siderable.

FILEIT is a lengthy program. For some systems it may be too large to run as a single program. This is not a serious problem since almost every option in FILEIT is done via subroutine calls. As a result, FILEIT can be thought of as groupings of modules, each performing a

separate task.

To run FILEIT on a smaller system, therefore, requires only that the necessary modules to perform a given task be made into a separate program. The most logical starting point for this breakout process is to make the data retrieval option (option 3) a separate program.

Table 1. Primary FILEIT variables.

A\$ Input/output string  
B\$ File name string  
C\$ Utility string for user responses and CONVERT function  
D\$ Holds user input data  
E\$ Label name string  
F\$ Null string. Used to null other strings when necessary  
G\$ User input string for selection criterion  
T\$ Used in purge blank record routine to hold nonblank information to fill blank record  
B() Holds record number of blank records in data base  
C() Used to hold column address for cursor control  
D() Length of individual data fields  
L() Length of individual labels  
R() Used to hold row address for cursor control  
LB() Holds variable number in user specified report option  
N() Holds numeric field designators  
RB() Holds and row and position address for user specified reports  
B1 Holds the number of records included in a 256 byte block  
D1 Used to determine the beginning position of a given data field within a record  
I3 Holds the variable number selected by the user to serve as the selection criterion for a record's inclusion in an output report.  
J1 Beginning address of a given label in the Label String E\$  
K1 Ending address of a given label in the Label String E\$

L1 1st CRT line data entry screen is to be displayed  
P8 Holds variables relative print position on a given row in user specified report option  
P9 Holds line length of printer or CRT device in user specified report option  
R0 User specified record number to be deleted  
S1 Switch used to tell screen print routine that screen is to be used for output and not input.  
S2 Switch = 1 if printer is on.  
S3 Switch = 1 in retrieve option to prevent printing of record number on selection criterion screen  
S7 Switch = 1 if correct record or delete record options being used. Causes screen print routine to output a single record.  
S8 Switch = 1 when creation of data base option first entered. Allows the creation of a single data base during a given run of FILEIT.  
S9 Switch = 1 keeps user from having to enter I/O device number and file name with each new option used.  
Z3 Holds number of records entered by user  
D Holds actual length of data record  
E Error code conditions for I/O operation to disk drives  
F Disk drive number where data base is to stored or is stored  
I Block counter in the creation option  
O Option number selected by user from option list  
R Maximum number of records in data base lists  
Z Total number of labels in a record



Similarly, the compress file option (option 6) could be made into a separate program.

FILEIT provides the user with several basic options that allow creation of a new data base or modification of an existing data base. These options are:

1. Create data base
2. Add records to data base
3. Retrieve records from data base
4. Correct records
5. Delete records
6. Compress data base

The discussion to follow will center on using these options. Minimal attention will be given to the source listing for FILEIT except to mention that numerous REMark statements have been added to the program listing to aid the deciphering process. Additionally, some of the more commonly used variables in the program are shown in Table 1. I hope these two aids will shed some light on what is going on in the program.

#### Option 1

**Create data base.** This option is used to create a new data base. As part of the creation process, FILEIT utilizes a previously created data entry screen file output by the SCREEN program. The user supplies the screen file name and the storage device number on which it is located.

The user then supplies the maximum number of records that could conceivably be in-

cluded in the data base. Since the user's response is used to allocate diskette space to the data base, care should be used to ensure that sufficient space is allocated for any future additions to the data base.

After space is allocated, information in the data entry screen file is transferred into records 0 through 3 of the data base, and a data entry screen for the first data record is presented to the user. From here the user enters information in response to the prompting "?" after each label.

After information is supplied for each label, an opportunity is given for correcting information entered. To correct an erroneous entry, simply type in its label. FILEIT will respond by blanking out the previously entered information with "c" indicating the length of the data field. After this, enter the correct information.

If no corrections are to be made, press RETURN. FILEIT will respond by asking if more records are to be entered. If so, pressing RETURN or entering a "Y" will cause the data entry screen to be refreshed for entry of a new record. If an "N" is entered, FILEIT will store any unstored information entered, update record zero for number of records entered and return the user to the options menu.

#### Option 2

*Add records to data base.*

#### FILEIT program.

```

10 CLOSE (0,E) : CLOSE (1,E)
20 DIM A$(256),B$(10),C$(10),D$(256),E$(512),C(30),D(30)
30 DIM R(30),L(30),F$(256)
40 DIM G$(256),T$(256),B(30)
50 DIM R$(30),L$(30),N(30)
60 H=" " : FOR I=1 TO 7 : H=" " : NEXT I
70 H=" " : FILE CREATION PROGRAM"
80 A$=" " : FOR I=1 TO 8 : A$=A$+A$ : NEXT I
90 D$=A$ : B$=A$(1,10) : C$=B$ : E$=A$+D$ : F$=A$
100 D$=A$ : T$=A$
110 FOR I=1 TO 5 : H=" " : NEXT I
120 INPUT "Enter input/output device number (0 or 1) ",F
130 IF F<0 OR F>1 THEN H="Only 0 or 1 allowed " : GOTO 120
140 H=" "
150 H="OPTIONS"
160 H=" 1. Create file"
170 H=" 2. Add records to file "
180 H=" 3. Retrieve records from file"
190 H=" 4. Correct records "
200 H=" 5. Delete records "
210 H=" 6. Compress file "
220 H=" 7. End processing"
230 H=" "
240 INPUT "Enter option number ",O
250 IF O<1 OR O>7 THEN 140
260 IF O=1 THEN 690
270 IF O=7 THEN 7300
280 IF S9=1 THEN 630
290 INPUT "Enter name of data file ",B$
300 IF LEN(B$)<6 THEN H="6 characters must be entered " : GOTO 290
310 S9=1
320 B$=B$+"."DA"+CHR$(0)
330 OPEN (1,E,B$,3,F)

```

```

340 IF E>=1 THEN 7160
350 GET (1,E,A$,0)
360 IF E>=1 THEN 7160
370 C$=A$(241,242) : CONVERT C$ TO Z : REM Z=NUMBER OF LABELS
380 C$=A$(243,244) : CONVERT C$ TO L1 : REM L1=1ST SCREEN LINE
390 C$=A$(245,246) : CONVERT C$ TO B1 : REM B1=RECORDS PER BLOCK
400 C$=A$(247,249) : CONVERT C$ TO D : REM D=LENGTH OF RECORD
410 C$=A$(250,252) : CONVERT C$ TO Z3 : REM Z3=NUMBER OF RECORDS
420 C$=A$(253,255) : CONVERT C$ TO R : REM R=MAX NUMBER OF RECORDS
430 FOR I=1 TO Z
440 C$=A$(I*2-1,I*2) : CONVERT C$ TO L(I)
450 C$=A$(I*2,I*2,120+I*2) : CONVERT C$ TO D(I)
460 NEXT I
470 FOR I=1 TO 2
480 GET (1,E,A$,I)
490 IF E>0 THEN 7160
500 E$(I*256-255,I*256)=A$
510 NEXT I
520 GET (1,E,A$,3)
530 IF E>0 THEN 7160
540 FOR I=1 TO Z
550 C$=A$(I*2-1,I*2) : CONVERT C$ TO R(I)
560 C$=A$(I*2,I*2,120+I*2) : CONVERT C$ TO C(I)
570 NEXT I
580 GET (1,E,A$,4)
590 FOR I=1 TO Z
600 C$=A$(I,I)
610 CONVERT C$ TO N(I)
620 NEXT I
630 IF O=2 THEN 4070
640 IF O=3 THEN 4480
650 IF O=4 THEN 4240
660 IF O=5 THEN 5710
670 IF O=6 THEN 6680
680 REM***** CREATE DATA BASE OPTION *****
690 IF S8=1 THEN H="This option not allowed "
700 IF S8=1 THEN FOR I=1 TO 500 : H=" " : NEXT I
710 IF S8=1 THEN 140
720 S8=1
730 INPUT "Enter screen file name ",B$
740 IF LEN(B$)<6 THEN H="6 characters must be entered " : GOTO 730
750 B$=B$+"."SE"+CHR$(0)
760 OPEN (0,E,B$,2,F)
770 IF E>=1 THEN 7160
780 INPUT "Enter name for data file ",B$
790 IF LEN(B$)<6 THEN H="6 characters must be entered " : GOTO 780
800 INPUT "Maximum number of records to be in file ",R
810 B$=B$+"."DA"+CHR$(0)
820 IF E>=1 THEN 7160
830 GET (0,E,A$,0)
840 IF E>=1 THEN 7160
850 C$=A$(241,242) : CONVERT C$ TO Z : REM NUMBER OF LABELS
860 C$=A$(243,244) : CONVERT C$ TO L1 : REM 1ST SCREEN LINE
870 C$=A$(245,246) : CONVERT C$ TO B1 : REM BLOCKING FACTOR
880 C$=A$(247,249) : CONVERT C$ TO D : REM RECORD LENGTH
890 R2=INT(R/B1)
900 A=R-B1*R2
910 R2=R2+S
920 IF A>0 THEN R2=R2+1
930 OPEN (1,E,B$,3,F,R2)
940 IF E>=1 THEN 7160
950 A$=F$ : REM BLANK OUT I/O STRING
960 H=" " : H="Making room for file on diskette "
970 FOR I=0 TO R2 : PUT (1,E,F$,I) : NEXT I
980 REM GET INFORMATION FROM DATA ENTRY SCREEN FILE
990 REM AND PUT IT IN RECORDS 0-4 OF DATA BASE FILE.
1000 GET (0,E,A$,0)
1010 IF E>=1 THEN 7160
1020 PUT (1,E,A$,0)
1030 IF E>=1 THEN 7160
1040 FOR I=1 TO Z
1050 C$=A$(I*2-1,I*2) : CONVERT C$ TO L(I) : REM LABEL LENGTHS
1060 C$=A$(I*2,I*2,120+I*2) : CONVERT C$ TO D(I) : REM DATA FIELD LENGTH
1070 NEXT I
1080 FOR I=1 TO 2
1090 GET (0,E,A$,I)
1100 IF E>=1 THEN 7160
1110 PUT (1,E,A$,I)
1120 IF E>=1 THEN 7160
1130 E$(I*256-255,I*256)=A$
1140 NEXT I
1150 GET (0,E,A$,3)
1160 IF E>=1 THEN 7160
1170 PUT (1,E,A$,3)
1180 IF E>=1 THEN 7160
1190 FOR I=1 TO Z
1200 C$=A$(I*2-1,I*2) : CONVERT C$ TO R(I) : REM ROW ADDRESSES
1210 C$=A$(I*2,I*2,120+I*2) : CONVERT C$ TO C(I) : REM COL ADDRESSES
1220 NEXT I
1230 GET (0,E,A$,4)
1240 FOR I=1 TO Z
1250 C$=A$(I,I)
1260 CONVERT C$ TO N(I)
1270 NEXT I
1280 REM CLOSE DATA ENTRY SCREEN FILE SINCE ITS DATA IS
1290 PUT (1,E,A$,4)
1300 REM NOW IN THE FIRST RECORDS OF DATA BASE FILE
1310 CLOSE (0,E)
1320 IF E>0 THEN 7160
1330 GOSUB 1350 : REM CALL DATA ENTRY SCREEN ROUTINE
1340 GOTO 140
1350 REM ***** DATA ENTRY SCREEN ROUTINE *****
1360 REM I IS BLOCK COUNTER. IT IS SET TO 5 FOR FILE CREATION.
1370 REM RECORDS 0-4 HOLD HOUSEKEEPING INFORMATION FOR DATA BASE.
1380 REM Z3 HOLDS ACTUAL NUMBER OF RECORDS ENTERED
1390 REM B2 SET TO 1 FOR FILE CREATION. CORRECTION OPTION
1400 REM SETS B2 TO RECORD SELECTED BY USER TO BE CORRECTED
1410 REM J HOLDS CURRENT RECORD WITHIN BLOCK
1420 REM S1 SWITCH THAT TELLS SCREEN PRINT ROUTINE THAT SCREEN
1430 REM IS TO BE USED FOR OUTPUT RATHER THAN INPUT
1440 REM L POINTS TO CURRENT LABEL FOR WHICH DATA IS TO BE
1450 REM ENTERED
1460 REM Z HOLDS THE NUMBER OF LABELS THAT MAKE UP A RECORD
1470 REM D$ HOLDS USER INPUT DATA
1480 REM D1 POINTS TO RECORD POSITION THAT DATA IS TO BE PLACED
1490 REM Z1 HOLDS ACTUAL AMOUNT OF DATA FIELD SPACE USED
1500 I=5 : Z3=0 : B2=1 : A$=F$
1510 FOR J=B2 TO B1
1520 S1=0
1530 GOSUB 2310 : REM GOTO DATA ENTRY SCREEN PRINT ROUTINE

```



```

1540 FOR L=1 TO Z
1550 CURSOR 15,0
1560 "
1570 IF Z3=R+1 THEN "Last record that can be input "; : GOTO 1600
1580 IF M1(L)=1 THEN CURSOR 15,0 : "Record ";Z3+1;" ** Numeric field";
1590 IF M1(L)=0 THEN CURSOR 15,0 : "Record ";Z3+1;
1600 CURSOR R(L),C(L)+L(L)
1610 D$=F$
1620 D1=D1+D(L)
1630 INPUT D$
1640 Z1=D(L)-LEN(D$)
1650 REM BLANK OUT "x"s THAT WERE NOT COVERED WITH USER INPUT
1660 REM DATA
1670 FOR Z2=1 TO Z1
1680 " ";
1690 NEXT Z2
1700 " ";
1710 REM NOTE: PROMPTING ? GENERATED BY INPUT1 STATEMENT
1720 REM IS ERASED BY THE NEXT LINE OF CODE
1730 CURSOR R(L),C(L)+L(L) : " ";
1740 IF M1(L)=0 THEN 1900
1750 IF LEN(D$)=D(L) THEN T$(1,D(L))=D$ : GOTO 1840
1760 IF LEN(D$)=0 AND M1(L)=1 THEN D$="0"
1770 V1=D(L)-LEN(D$)+1 : V2=V1-1
1780 IF V1<0 THEN S0=1 : GOSUB 7350 : GOTO 1630
1790 T$(V1,D(L))=D$
1800 FOR K9=1 TO V2
1810 T$(K9,K9)="0"
1820 NEXT K9
1830 D$=T$(1,D(L))
1840 FOR K9=1 TO D(L)
1850 C$=T$(K9,K9)
1860 IF ASC(C$)=46 OR ASC(C$)=45 THEN 1890
1870 IF ASC(C$)<48 OR ASC(C$)>57 THEN GOSUB 7350
1880 IF ASC(C$)<48 OR ASC(C$)>57 THEN EXIT 1630
1890 NEXT K9
1900 A$(J=D-D1+(D1-D(L)-1)),J+D-D1=D$
1910 NEXT L
1920 CURSOR 15,0
1930 "
1940 CURSOR 15,0
1950 "
1960 CURSOR 15,0
1970 "Correction ";
1980 INPUT C$
1990 REM IF USER WANTS TO CORRECT ERROR GOTO CORRECTION ROUTINE
2000 IF C$="Y" OR C$="y" THEN GOSUB 2790 : REM CALL CORRECT DATA
2010 CURSOR 15,0
2020 "
2030 CURSOR 15,0
2040 Z3=Z3+1
2050 "More to be entered ";
2060 INPUT C$
2070 IF C$="N" OR C$="n" THEN 2160
2080 NEXT J
2090 B2=1
2100 REM DATA BLOCK MUST BE FULL, WRITE IT OUT TO STORAGE DEVICE
2110 PUT (1,E,A$,1)
2120 IF E>=1 THEN 7160
2130 I=I+1 : A$=F$
2140 GOTO 1510
2150 REM STORE AWAY ANY DATA ENTERED SINCE LAST STORE
2160 PUT (1,E,A$,1)
2170 REM UPDATE RECORD ZERO FOR NUMBER OF RECORDS ENTERED AND
2180 REM MAXIMUM NUMBER OF RECORDS THAT CAN BE PLACED IN FILE
2190 GET (1,E,A$,0)
2200 IF E>=1 THEN 2800
2210 CONVERT Z3 TO C$(###)
2220 A$(250,252)=C$
2230 CONVERT R TO C$(###)
2240 A$(253,255)=C$
2250 REM STORE UPDATED RECORD ZERO
2260 PUT (1,E,A$,0)
2270 IF E>=1 THEN 7160
2280 IF S8=1 THEN CLOSE (1,E) : OPEN (1,E,B$,3,F) : S9=1
2290 RETURN
2300 REM
2310 REM ***** SCREEN PRINT ROUTINE *****
2320 REM
2330 REM B1 HOLDS POSITION COUNTER FOR DATA WITHIN RECORD
2340 REM J1 HOLDS BEGINNING ADDRESS OF LABEL IN E$
2350 REM S3 SWITCH SET IN RETRIEVE RECORD OPTION
2360 REM S2 SWITCH SET TO 1 IF PRINTER ON
2370 REM S1 SWITCH SET TO 1 IF SCREEN FOR OUTPUT NOT INPUT
2380 REM S7 SWITCH SET TO 1 IN CORRECT OR DELETE RECORDS OPTIONS
2390 REM TELLS SCREEN PRINT TO OUTPUT A SINGLE RECORD
2400 REM W9 NUMBER OF LINES TO SEPARATE PRINTED RECORDS
2410 REM K1 HOLDS ENDING ADDRESS OF LABEL IN E$
2420 " "
2430 D1=0
2440 J1=1
2450 IF S3=1 THEN 2470
2460 IF S2=1 THEN HTAB(60) : "Record ";Z4
2470 S3=0
2480 FOR I1=1 TO Z
2490 REM IF PRINTER ON AND ROW NUMBERS DIFFER, THEN PRINT
2500 REM A BLANK TO FORCE A CARRIAGE RETURN AND LINE FEED
2510 IF S2=1 AND R(I1-1)<R(I1) THEN " "
2520 CURSOR R(I1),C(I1)
2530 K1=J1+L(I1)-1
2540 HE$(J1,K1);
2550 " ";
2560 J1=K1+1
2570 D1=D1+D(I1)
2580 IF S1=1 THEN 2640
2590 REM DISPLAY "x"s TO INDICATE LENGTH OF DATA FIELD
2600 FOR M1=1 TO D(I1)
2610 "x";
2620 NEXT M1
2630 GOTO 2660
2640 A$(J=D-D1+(D1-D(I1)-1)),J+D-D1=D1;
2650 IF S2=1 THEN " ";
2660 NEXT I1
2670 IF S7=1 THEN RETURN
2680 IF S1=0 THEN 2760
2690 IF S2=1 THEN 2760
2700 CURSOR 15,0
2710 "
2720 CURSOR 15,0 : IF S2=1 THEN 2760
2730 " Record ";Z3;Z4;" ";
2740 INPUT "Hit CR for next record ",C$

```

This option is used to add records to an existing data base. Records added are appended to those already in the file. This is done automatically and does not require any effort on the user's part.

In the record addition process, FILEIT informs the user of the number of records in the file and the number of records the file can hold. After this, addition of records to the data base proceeds in a manner similar to that described in option 1 when the file was originally created.

### Option 3

*Retrieve records from data base.* The user can have records meeting a specified criterion or all records in the data base output to the CRT or to the system's printer (answer "Y" to the printer request). The user can use the screen entry format as the format for the output, or the user can specify his own format.

To specify his own format, the user inputs a 2 to the suboption request. The user is then asked if a previously specified report format is to be used. If the answer is "Y," the name of the report format file and the disk drive where it is stored is requested. If a carriage return is entered, the user must enter the report format.

To specify a format the user is asked to provide the report line number where he wants a particular label and its associated data field to appear on the report. Additionally, the user is asked to provide the label's relative position on the given line. If a line number of 15 or more is given, the item will not be printed or displayed. Also, report line numbers need not be entered in any particular order since after the entry of each label's line number all label positions are sorted in order.

If too much print information is indicated for a line, a "line too long" message will be displayed. If this occurs, simply put the label on another report line.

One other aspect of option 3 is that the user can specify a single criterion for records' inclusion in a report. Just type in the criterion after the label on the screen. A carriage return will

move you through the labels until you reach the one which is wanted for selection purposes.

If all records in the data base are to be included in the report, keep hitting the carriage return until you have passed through all labels. Once a carriage return has been entered for the last label, the report generation process begins. (NOTE: If the user specifies a criterion, the report generation process will begin after the criterion's specification.)

### Option 4

*Correct records.* This option allows the user to correct erroneous records in previously created data files. To accomplish this, the user enters the number of the record to be corrected. FILEIT responds by displaying the record on the CRT and asking for the erroneous data field's identifying label. The correction process then proceeds in a manner identical to that described in correcting records at the time of data file creation.

### Option 5

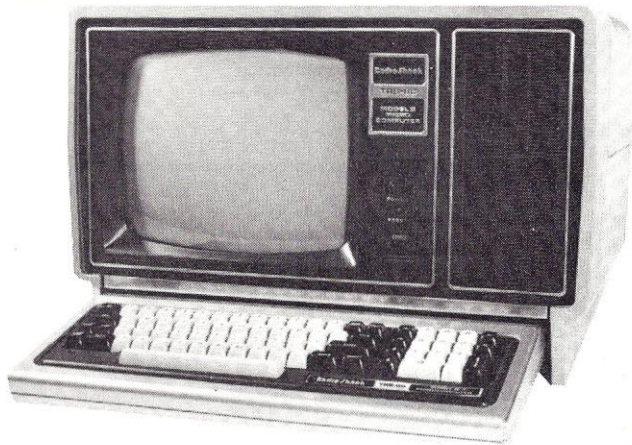
*Delete records.* The delete record option is used to eliminate records from the data base found no longer valid or useful. Records are deleted by blanking them out. Under the retrieve option, these records will appear as blank data. To delete records, the user enters the number of the record to be deleted. FILEIT displays the record and asks if it is to be deleted. Answering "Y" to the query will cause the record to be blanked out.

### Option 6

*Compress data base.* The compress option squeezes blank records out of the data base resulting from record deletions. Calling this option automatically causes FILEIT to move nonblank records from the end of the file into blank spaces in earlier parts of the file.

These two programs, SCREEN and FILEIT, together offer a method of avoiding a lot of the drudgery associated with data files. I hope that they will be a worthwhile addition to your software library. ■





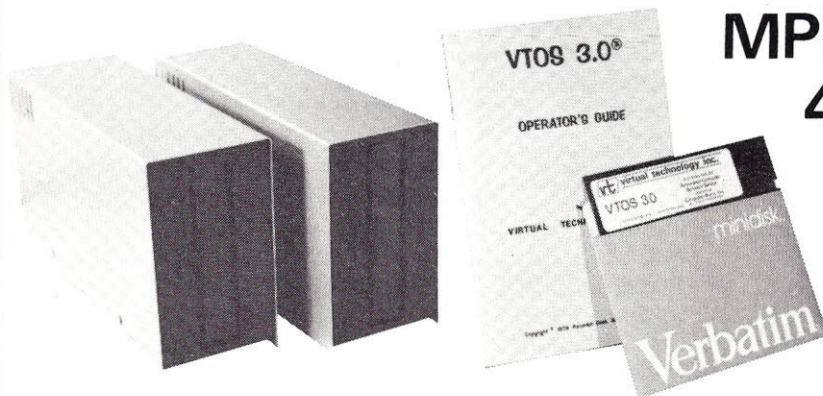
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2750  " " ;
2760 IF S2=1 THEN FOR W0=1 TO W9 : " " : NEXT W0
2770 D1=0
2780 RETURN
2790 REM ***** CORRECT DATA WITHIN RECORD ROUTINE *****
2800 CURSOR 15,0
2810 " " ;
2820 CURSOR 15,0
2830 "Enter label of data field to be corrected ";
2840 INPUT D$
2850 J1=1 : D1=0
2860 REM FIND THE LABEL THE USER SAID HAD INCORRECT DATA
2870 FOR I1=1 TO Z
2880 K1=J1+L(I1)-1
2890 D1=D1+D(I1)
2900 IF D$=E$(J1,K1) THEN 3010
2910 J1=K1+1
2920 NEXT I1
2930 CURSOR 15,0
2940 " " ;
2950 CURSOR 15,0
2960 "Label not found ";
2970 FOR I=1 TO 500 : " " : NEXT I
2980 CURSOR 15,0
2990 " " ;
3000 GOTO 3350
3010 CURSOR 15,0
3020 " " ;
3030 CURSOR 15,0
3040 L=I1
3050 IF N1(I1)=1 THEN "Numeric field ";
3060 REM IF LABEL IS FOUND POSITION CURSOR AND DISPLAY PROMPTING
3070 REM "C's" TO INDICATE LENGTH OF DATA FIELD.
3080 CURSOR R(I1),C(I1)+L(I1)+1
3090 FOR I2=1 TO D(I1) : "C" : NEXT I2 : " " ;
3100 CURSOR R(I1),C(I1)+L(I1)
3110 U$=1 : REM KEEP NUMERIC INFORMATION ROUTINE FROM PRINTING "X"
3120 INPUT D$
3130 Z1=D(I1)-LEN(D$)
3140 REM BLANK OUT ANY UNUSED DATA SPACE TO PRETTY UP DISPLAY.
3150 FOR J2=1 TO Z1 : " " : NEXT J2
3160 " " ;
3170 CURSOR R(I1),C(I1)+L(I1) : " " ;
3180 IF N1(I1)=0 THEN 3330
3190 IF LEN(D$)=D(I1) THEN V1=1 : GOTO 3230
3200 IF LEN(D$)=0 AND N1(I1)=1 THEN D$="0"
3210 V1=D(I1)-LEN(D$)+1
3220 IF V1<0 THEN 501 : GOSUB 7350 : GOTO 3010
3230 T$(V1,D(I1))-D$ : V2=V1-1
3240 FOR K9=1 TO V2
3250 T$(K9,K9)="0"
3260 NEXT K9
3270 D$=T$(1,D(I1))
3280 FOR K9=1 TO D(I1)
3290 C$=T$(K9,K9)
3300 IF ASC(C$)=46 OR ASC(C$)=45 THEN 3320
3310 IF ASC(C$)<48 OR ASC(C$)>57 THEN GOSUB 7350 : EXIT 3010
3320 NEXT K9
3330 A$(J=D-D+(D1-(D(I1)-1)),J=D-D+D1)=F$(J=D-D+(D1-(D(I1)-1)),J=D-D+D1)
3340 A$(J=D-D+(D1-(D(I1)-1)),J=D-D+D1)=D$
3350 S1=1
3360 CURSOR 15,0
3370 " " ;
3380 CURSOR 15,0
3390 "More corrections ";
3400 INPUT C$
3410 IF C$="Y" OR C$="y" THEN 2790
3420 RETURN
3430 REM
3440 REM
3450 REM ***** SELECTION ROUTINE *****
3460 REM
3470 J1=1 : D1=0
3480 " " ;
3490 GOSUB 2310 : REM CALL SCREEN PRINT ROUTINE
3500 CURSOR 15,0
3510 " " ;
3520 CURSOR 15,0
3530 "Enter selection criterion at ? above ";
3540 D1=0 : I3=0 : REM 13 HOLDS NUMBER OF LABEL SELECTED
3550 FOR I1=1 TO Z
3560 CURSOR R(I1),C(I1)+L(I1)
3570 G$=F$
3580 D1=D1+D(I1)
3590 INPUT G$(D1-(D(I1)-1),D1)
3600 " " ;
3610 D$=G$(D1-(D(I1)-1),D1)
3620 FOR Z2=1 TO D(I1)
3630 IF G$(D1-D(I1)+Z2,D1-(D(I1)+Z2+1))=" " THEN EXIT 3660
3640 NEXT Z2
3650 REM BLANK OUT "X's" IF FIELD IS NOT SELECTED
3660 Z2=D(I1)-Z2 : FOR Z5=1 TO Z2 : " " : NEXT Z5
3670 CURSOR R(I1),C(I1)+L(I1) : " " ;
3680 IF G$(D1-(D(I1)-1),D1-D(I1)-1)=" " THEN 3700
3690 EXIT 3790
3700 NEXT I1
3710 CURSOR 15,0
3720 " " ;
3730 CURSOR 15,0
3740 "No selection criterion selected";
3750 FOR C0=1 TO 500 : " " : NEXT C0
3760 D$="ALL"
3770 RETURN
3780 REM STORE LABEL SELECTED BY USER IN I3
3790 I3=I1 : B2=D1
3800 RETURN
3810 REM ***** READ FILE ROUTINE *****
3820 S1=1
3830 B2=INT(80/B1) : A=B0-B1*B2 : B2=B2+4 : IF A>0 THEN B2=B2+1
3840 IF A=0 THEN A=B1
3850 E2=INT(E0/B1) : E3=E0-B1*E2 : E2=E2+4 : IF E3>0 THEN E2=E2+1
3860 Z4=B0-1
3870 FOR B=B2 TO E2
3880 GET (1,E,A$,B)
3890 IF E>1 THEN "GET ERROR " : STOP
3900 FOR J=A TO B1
3910 Z4=Z4+1 : IF Z4=E0+1 THEN EXIT 4050
3920 D1=0
3930 FOR L1=1 TO Z
3940 IF D$="ALL" OR D$="all" THEN EXIT 4010

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3950 D1=D1+D(L1)
3960 X=J=D-D+(D1-(D(L1)-1))
3970 Y=J=D-D+D1
3980 IF G$(D2-(D(I3)-1),D2)=A$(X,Y) THEN EXIT 4010
3990 NEXT L1
4000 GOTO 4020
4010 GOSUB 2430 : REM CALL SCREEN PRINT ROUTINE
4020 NEXT J
4030 A=1
4040 NEXT B
4050 S1=0 : D1=0
4060 RETURN
4070 REM ***** ADD RECORDS OPTION *****
4080 " " ;
4090 "Currently ";Z3;" records in file "
4100 R2=R
4110 "File can hold as many as ";R2;" records"
4120 " " ;
4130 INPUT "Hit CR to begin entry of new data ",C$
4140 X1=INT(Z3/B1)
4150 A=Z3-X1*B1
4160 IF A>0 THEN X1=X1+1
4170 I=4+X1
4180 B2=A+1
4190 IF A=0 THEN I=I+1
4200 GET (1,E,A$,I)
4210 IF E>1 THEN 7160
4220 GOSUB 1510 : REM CALL DATA ENTRY SCREEN ROUTINE
4230 GOTO 140
4240 REM ***** CORRECT RECORD OPTION *****
4250 S7=1 : S1=1 : L8=0
4260 " " ;
4270 INPUT "Enter record number to be corrected ",L9
4280 L8=INT(L9/B1)
4290 A=L9-L8*B1
4300 IF A>0 THEN L8=L8+1
4310 I=4+L8
4320 L8=L8+4
4330 IF A=0 THEN A=B1
4340 GET (1,E,A$,L8)
4350 IF E>1 THEN 7160
4360 J=A
4370 GOSUB 2310 : REM CALL SCREEN PRINT ROUTINE
4380 GOSUB 2790 : REM CALL CORRECT DATA ROUTINE
4390 PUT (1,E,A$,L8)
4400 IF E>1 THEN 7160
4410 CURSOR 15,0
4420 " " ;
4430 CURSOR 15,0
4440 INPUT "Another record to be corrected ",C$
4450 IF C$="Y" OR C$="y" THEN 4260
4460 S1=0 : A$=F$ : S7=0
4470 GOTO 140
4480 REM ***** RETRIEVE RECORDS OPTION *****
4490 S1=0
4500 " " ;
4510 INPUT "OPTIONS 1. Screen report 2. Specified report ",0
4520 IF 0<1 OR 0>2 THEN 4510
4530 INPUT "Printer on ? (Y/N) ",C$
4540 REM IF USER WANTS PRINTER ON, SET S2=1
4550 IF C$="Y" OR C$="y" THEN S2=1 ELSE S2=0
4560 IF S2=1 THEN INPUT "How many lines between records ",W9
4570 S3=1
4580 INPUT "Enter beginning record to be output ",B0
4590 IF B0<1 THEN "Record must be one or more " : GOTO 4580
4600 IF B0>Z3 THEN "Only ";Z3;" records in file " : GOTO 4580
4610 "Z3;" records in file"
4620 INPUT "Enter ending record to be output ",E0
4630 IF E0>Z3 THEN "Only ";Z3;" records in file " : GOTO 4620
4640 IF E0<B0 THEN "Beginning more than ending " : GOTO 4620
4650 INPUT "Want to specify a selection criterion (Y/N) ",C$
4660 IF C$="Y" OR C$="y" THEN 4710
4670 " " ;
4680 D$="ALL" : S3=0 : GOTO 4720
4690 REM PROVIDE USER WITH DATA ENTRY SCREEN TO SEE IF ONLY
4700 REM DATA MEETING A SPECIFIED CRITERION IS TO BE OUTPUT.
4710 GOSUB 3450 : REM CALL SELECTION ROUTINE
4720 REM
4730 IF 0=2 THEN 4820
4740 IF S2=1 THEN " " : "Output is being printed"
4750 IF S2=1 THEN CLOSE (CRT,E)
4760 IF S2=1 THEN OPEN (PRINTER,E)
4770 GOSUB 3810 : REM CALL READ DATA BASE ROUTINE
4780 CLOSE (PRINTER,E)
4790 OPEN (CRT,E)
4800 GOTO 140
4810 REM
4820 " " ;
4830 REM P9 HOLDS PRINTER LINE LENGTH. INITIALLY SET TO CRT LINE LENGTH
4840 P9=43
4850 INPUT "Is report format on file ",C$
4860 REM IF REPORT FORMAT ON FILE GOTO GET REPORT FORMAT ROUTINE
4870 IF C$="Y" OR C$="y" THEN Z1=1 : GOSUB 6480
4880 IF Z1=1 THEN 5180
4890 IF S2=1 THEN INPUT "Enter printer line length ",P9
4900 J1=1
4910 FOR I1=1 TO Z
4920 K1=J1+L(I1)-1
4930 R9=0
4940 "Label";Z2:I1;" "E$(J1,K1)
4950 INPUT "Enter label report line and position ",R9,P8
4960 R9=R9+.01*P8
4970 IF Z0=1 THEN R8(K3)=R9 : Z0=0 : GOTO 4990
4980 R8(I1)=R9 : L8(I1)=I1
4990 GOSUB 6040 : REM CALL SORT ROUTINE
5000 D1=0
5010 FOR K2=1 TO I1
5020 IF INT(R8(K2))<>INT(R8(K2-1)) THEN D1=0
5030 D1=D1+D(K2)+L(K2)+3
5040 IF D1>P9 THEN "Line too long " : EXIT 5070
5050 NEXT K2
5060 GOTO 5110
5070 FOR K3=1 TO I1
5080 IF R8(K3)=R9 THEN EXIT 5100
5090 Z0=1 : NEXT K3
5100 GOTO 4930
5110 J1=K1+1
5120 NEXT I1
5130 INPUT "Do you want to save report format ",C$
5140 IF C$="Y" OR C$="y" THEN GOSUB 6250

```



```

5150 ""
5160 IF S2=1 THEN CURSOR 7,0 : "Output is being printed"
5170 IF S2=1 THEN CLOSE (CRT,E) : OPEN (PRINTER,E)
5180 REM ***** REPORT GENERATION AREA *****
5190 REM
5200 REM Z3 HOLDS NUMBER OF RECORDS IN DATA BASE
5210 REM W8 HOLDS THE NUMBER OF RECORDS OUTPUT
5220 REM B1 HOLDS THE NUMBER OF RECORDS PER BLOCK
5230 REM W9 HOLDS NUMBER OF LINE TO BE PRINTED BETWEEN RECORDS
5240 REM D4,G4 THESE STRINGS GET VALUES FROM SELECTION ROUTINE
5250 B2=INT(B0/B1) : A=B0-B1*B2 : B2=B2+4 : IF A>0 THEN B2=B2+1
5260 IF A=0 THEN A=B1
5270 E2=INT(E0/B1) : E3=E0-B1*E2 : E2=E2+4 : IF E3>0 THEN E2=E2+1
5280 IF S2=1 THEN OPEN (PRINTER,E)
5290 W8=0
5300 FOR Z1=B2 TO E2
5310 GET (1,E,A$,Z1)
5320 IF E>=1 THEN EXIT 7160
5330 FOR J9=A TO B1
5340 W8=W8+1 : IF W8=E0+1 THEN EXIT 5660
5350 S0=0 : IF D4="ALL" THEN 5460
5360 FOR I2=1 TO Z
5370 J1=0 : D1=0 : K1=0
5380 FOR I9=1 TO L8(I2)
5390 J1=K1+1 : K1=J1+L(I9)-1 : D1=D1+D(I9)
5400 NEXT I9
5410 U=D(L8(I2))
5420 IF G4(D2-(D(I3)-1),D2)=A$(J9*D-D1+(U-1)),J9*D-D1+1 THEN S0=1
5430 IF S0=1 THEN EXIT 5460
5440 NEXT I2
5450 GOTO 5650
5460 FOR I1=1 TO Z
5470 J1=0 : D1=0 : K1=0
5480 FOR I9=1 TO L8(I1)
5490 J1=K1+1
5500 K1=J1+L(I9)-1
5510 D1=D1+D(I9)
5520 NEXT I9
5530 IF INT(R8(I1))<>INT(R8(I1-1)) THEN ""
5540 REM ANY LINE NUMBER GREATER THAN 14 IS IGNORED FOR OUTPUT
5550 IF INT(R8(I1))>14 THEN 5580
5560 U=D(L8(I1))
5570 W$(J1,K1);"";A$(J9*D-D1+(U-1)),J9*D-D1+1;""
5580 NEXT I1
5590 IF S2=0 THEN 5630
5600 FOR W0=1 TO W9
5610 ""
5620 NEXT W0
5630 IF S2=0 THEN ""
5640 IF S2=0 THEN INPUT "Press RETURN to continue ",C$
5650 NEXT J9
5660 NEXT Z1
5670 CLOSE (PRINTER,E)
5680 OPEN (CRT,E)
5690 S2=0
5700 GOTO 140
5710 REM ***** DELETE RECORDS ROUTINE *****
5720 ""
5730 INPUT "Enter record number to be deleted ",R0
5740 IF R0>Z3 THEN "Exceeds number of records in file " : GOTO 5730
5750 IF R0<0 THEN "There are no negative records " : GOTO 5730
5760 B=INT(R0/B1)
5770 A=R0-B*B1
5780 IF A>0 THEN B=B+1
5790 B=B+4
5800 GET (1,E,A$,B)
5810 IF E>=1 THEN 7160
5820 IF A=0 THEN A=B1
5830 J=A
5840 REM S1=1 TELLS SCREEN PRINT ROUTINE THAT DATA IS TO BE OUTPUT
5850 REM S7=1 TELLS SCREEN PRINT ROUTINE TO PRINT ONLY ONE RECORD
5860 S1=1 : S7=1
5870 GOSUB 2310 : REM CALL SCREEN PRINT ROUTINE
5880 CURSOR 15,0
5890 ""
5900 CURSOR 15,0
5910 INPUT1 "Delete record (Y/N) ",C$
5920 IF C$="Y" OR C$="y" THEN 5940
5930 GOTO 5970
5940 A$(J*D-(D-1),J*D)=F$(J*D-(D-1),J*D)
5950 PUT (1,E,A$,B)
5960 IF E>=1 THEN 7160
5970 CURSOR 15,0
5980 ""
5990 CURSOR 15,0
6000 INPUT1 "Another to be deleted ",C$
6010 IF C$="Y" OR C$="y" THEN 5710
6020 S1=0 : S7=0
6030 GOTO 140
6040 REM ***** SORT ROUTINE *****
6050 REM SORT ROUTINE WAS TAKEN FROM "A COMPARISON OF SORT ROUTINES"
6060 REM BY JOHN P. GRILLO, CREATIVE COMPUTING NOV-DEC 1976
6070 Y=11
6080 M6=11
6090 M6=INT(M6/2)
6100 IF M6=0 THEN 6240
6110 K6=Y-M6
6120 J6=1
6130 I6=J6
6140 L6=I6+M6
6150 IF R8(I6)=R8(L6) THEN 6210
6160 T(1)=R8(I6) : T(2)=L8(I6)
6170 R8(I6)=R8(L6) : L8(I6)=L8(L6)
6180 R8(L6)=T(1) : L8(L6)=T(2)
6190 I6=I6-M6
6200 IF I6>1 THEN 6140
6210 J6=J6+1
6220 IF J6>K6 THEN 6090
6230 GOTO 6130
6240 RETURN
6250 REM ***** SAVE REPORT FORMAT ROUTINE *****
6260 INPUT "Enter output device number ",F
6270 IF F<0 OR F>1 THEN 6260
6280 INPUT "Enter report file name ",B$
6290 B$=B$+".FT"+CHR$(0)
6300 OPEN (3,E,B$,1,F)
6310 A$=F$
6320 FOR I1=1 TO Z
6330 T0=R8(I1)*100
6340 CONVERT TO C$(####)

```

```

6350 A$(I1*4-3,I1*4)=C$
6360 NEXT I1
6370 CONVERT P9 TO C$(####)
6380 A$(241,243)=C$
6390 PUT (3,E,A$,0)
6400 A$=F$
6410 FOR I1=1 TO Z
6420 CONVERT L8(I1) TO C$(##)
6430 A$(I1*2-1,I1*2)=C$
6440 NEXT I1
6450 PUT (3,E,A$,1)
6460 CLOSE (3,E)
6470 RETURN
6480 REM ***** GET REPORT FORMAT ROUTINE *****
6490 INPUT "Enter input device number ",F
6500 INPUT "Enter report file name ",B$
6510 B$=B$+".FT"+CHR$(0)
6520 OPEN (3,E,B$,2,F)
6530 GET (3,E,A$,0)
6540 FOR I1=1 TO Z
6550 C$=A$(I1*4-3,I1*4)
6560 CONVERT C$ TO R8(I1)
6570 R8(I1)=R8(I1)*.01
6580 NEXT I1
6590 C$=A$(241,243)
6600 CONVERT C$ TO P9
6610 GET (3,E,A$,1)
6620 FOR I1=1 TO Z
6630 C$=A$(I1*2-1,I1*2)
6640 CONVERT C$ TO L8(I1)
6650 NEXT I1
6660 CLOSE (3,E)
6670 RETURN
6680 REM ***** PURGE BLANK RECORDS ROUTINE *****
6690 REM
6700 REM THIS ROUTINE SEARCHES THE FILE FOR BLANK RECORDS AND STORES
6710 REM THEIR LOCATION IN ARRAY B. NONBLANK RECORDS ARE THEN
6720 REM TAKEN FROM THE END OF THE FILE TO FILL IN THE BLANKS
6730 REM
6740 A$="" : FOR I=1 TO 8 : A$=A$+A$ : NEXT I : F$=A$ : T$=F$
6750 B=INT(Z3/B1)
6760 A=Z3-B*B1
6770 IF A>0 THEN B=B+1
6780 B=B+5 : K1=0 : Z0=0
6790 FOR I1=5 TO 8
6800 GET (1,E,A$,I1)
6810 FOR J1=1 TO B1
6820 IF Z0=Z3 THEN EXIT 6860
6830 Z0=Z0+1
6840 IF A$(J1*D-(D-1),J1*D)=F$(D-(D-1),D) THEN K1=K1+1 : B(K1)=Z0
6850 NEXT J1
6860 NEXT I1
6870 FOR I1=1 TO K1
6880 B2=INT(B(I1)/B1)
6890 A2=B(I1)-B2*B1
6900 IF A2>0 THEN B2=B2+1
6910 B2=B2+4
6920 IF A2=0 THEN A2=B1
6930 B=INT(Z3/B1)
6940 A=Z3-B*B1
6950 IF Z3<B(I1) THEN EXIT 7110
6960 IF A>0 THEN B=B+1
6970 B=B+4
6980 IF A=0 THEN A=B1
6990 GET (1,E,A$,B)
7000 IF A$(A*D-(D-1),A*D)=F$(D-(D-1),D) THEN Z3=Z3-1 : GOTO 6930
7010 IF A$(A*D-(D-1),A*D)=F$(D-(D-1),D) AND B(I1)=Z3 THEN Z3=Z3-1 : EXIT 7110
7020 Z3=Z3-1
7030 T$(A*D-(D-1),A*D)=A$(A*D-(D-1),A*D)
7040 A$(A*D-(D-1),A*D)=F$(D-(D-1),D)
7050 PUT (1,E,A$,B)
7060 GET (1,E,A$,B2)
7070 A$(A2*D-(D-1),A2*D)=T$(A*D-(D-1),A*D)
7080 PUT (1,E,A$,B2)
7090 NEXT I1
7100 REM UPDATE RECORD ZERO FOR NEW RECORD COUNT
7110 GET (1,E,A$,0)
7120 CONVERT Z3 TO C$(####)
7130 A$(250,252)=C$
7140 PUT (1,E,A$,0)
7150 GOTO 140
7160 REM ***** DISK ERROR ROUTINES *****
7170 IF E=1 THEN "FILE NOT FOUND."
7180 IF E=2 THEN "NOT ENOUGH ROOM ON DISKETTE"
7190 IF E=3 THEN "DUPLICATE FILE NAME ON DISKETTE"
7200 IF E=4 THEN "FILE NOT OPEN"
7210 IF E=5 THEN "END OF FILE ENCOUNTERED"
7220 IF E=6 THEN "FILE ALREADY OPENED"
7230 IF E=9 THEN "SYSTEM ERROR"
7240 IF E=12 THEN "TOO MANY OUTPUT FILES ON ONE DRIVE"
7250 IF E>0 THEN "ALL FILE HAVE BEEN CLOSED"
7260 IF E>0 THEN CLOSE (0,E) : CLOSE (1,E) : CLOSE (2,E) : CLOSE (3,E)
7270 IF E>0 THEN "ALL PROCESSING STOPPED"
7280 END
7290 REM ***** END OF PROCESSING *****
7300 CLOSE (0,E)
7310 CLOSE (1,E)
7320 CLOSE (3,E)
7330 "End of processing"
7340 END
7350 REM ***** INCORRECT NUMERIC FIELD INFORMATION ROUTINE*****
7360 CURSOR 15,0
7370 ""
7380 CURSOR 15,0
7390 IF S0=1 THEN "Field length exceeded " : S0=0 : GOTO 7410
7400 "Numeric information only please";
7410 CURSOR R(L),C(L)+L(L) : ""
7420 IF U8=1 THEN 7480
7430 FOR M1=1 TO D(L)
7440 "u";
7450 NEXT M1
7460 ""
7470 CURSOR R(L),C(L)+L(L)
7480 FOR U7=1 TO 225 : # : NEXT U7
7490 U8=0
7500 RETURN

```

Multiple statements on a single line following an IF statement execute when the IF statement tests true and doesn't terminate with an ELSE condition. If the statement is false and not terminated with an ELSE, they will be ignored.



# Relieve SWTP Tape Drudgery

*Generate MIKBUG-compatible tapes with the D2 kit.*

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Dept. of Physics  
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Singapore 10

When hand-loading a machine-language program using a keyboard into a 6800 system such as the SWTP, you are tying up your system. Many owners of the SWTP and other 6800 systems also possess an MEK 6800D2 kit, which has a hex keypad. The D2 kit has a Kansas City Standard cassette interface, which reads and generates tapes in a binary format not compatible with the usual MIKBUG "S" format.

The accompanying program, D2MIKPUN, enables the D2 kit to generate MIKBUG-format

tapes. In this way, you can use the D2 kit to hand-load machine code, which can be dumped onto a cassette for subsequent loading into the main SWTP or other 6800 system.

The program also puts onto the MIKBUG tape an address, which can be specified by the user and which may be different from that of the D2 kit memory in which the code resides. In this way, you can hand-load blocks of code into the D2 and dump them on tape with successive blocks of addresses meant for the larger 6800 system.

## How It Works

The program makes use of the D2's JBUG routine and occupies 128 bytes from hex 0000 to

007F. The D2 comes with 256 bytes of RAM; the next 128 bytes from hex 0080 to 00FF may be used for loading the machine code. A long program several kilobytes long may be loaded and dumped on tape in 128-byte blocks with the correct addresses for the larger 6800 system.

To use the program, load it into the D2 manually. The program may then be saved on tape in the D2 binary format for future use. The desired machine code is then loaded manually into the remaining D2 RAM.

To generate the MIKBUG tape, the following RAM locations must be loaded (all addresses in hex):

A000—high byte of beginning

address on MIKBUG tape  
A001—low byte of beginning address on MIKBUG tape  
A002—high byte of beginning address in D2 memory  
A003—low byte of beginning address in D2 memory  
A004—high byte of ending address in D2 memory  
A005—low byte of ending address in D2 memory

On executing a GO to the start of D2MIKPUN at hex 0003, the MIKBUG tape is punched. One nice feature is that after punching, the beginning address in hex A000/A001 for the next block, if contiguous, is set to the correct value. With this program the D2 becomes an off-line loading terminal for a larger 6800 system. ■

D2MIKPUN program.

```

      *          NAM           D2MIKUPUN
      * OFFSET MIKEUG TAPE PUNCH PROGRAM
      * FOR MEK600D2 KIT
      * BY B.T.G. TAN, UNIVERSITY OF SINGAPORE
      * THIS PROGRAM ALLOWS THE D2 KIT TO PUNCH
      * MIKBUG FORMAT TAPES WITH BEGINNING
      * ADDRESS ON TAPE DIFFERENT FROM THAT OF
      * THE D2 MEMORY WHOSE CONTENTS ARE BEING
      * PUNCHED. ADDRESSES TO BE STORED AS FOLLOWS:
      * $A000 AND $A001: BEGINNING ADDRESS TO
      *                     BE PUNCHED
      * $A002 AND $A003: BEGINNING ADDRESS IN D2
      *                     MEMORY
      * $A004 AND $A005: ENDING ADDRESS IN D2 MEMORY
      *
0008             ACIAC       OPT        NOP                ACIA CONTROL REGISTER
E0AC             INIT       EQU         $B008              JBUG CONTROL
E37A             OUTCH     EQU         $E37A              JBUG OUTPUT SUBROUTINE
E3B7             PUN       EQU         $E3B7              JBUG PUNCH SUBROUTINE
A000             ORG        $A000
A000             PBEGA      RMB         2                PUNCH BEGINNING ADDRESS
A002             BEGA      RMB         2                MEMORY BEGINNING ADDRESS
A004             ENDA      RMB         2                MEMORY END ADDRESS
0000             ORG        0
0000             TW        RMB         2                TEMPORARY BEGINNING ADDRESS
0002             TEMP      RMB         1                BYTE COUNT


      * PROGRAM STARTS HERE
0003 86 51             LDA A    ##$1            INITIALIZE ACIAC
0005 B7 80 08          STA A    ACIAC
0008 FE A0 02          LDX      BEGA
000B DF 00             STX      TW                STORE TEMP BEGINNING ADDRESS
000D B6 A0 05 PUNCH1   LDA A    ENDA+1
0010 90 01             SUB A    TW+1
0012 F6 A0 04          LDA B    ENDA
0015 D2 00             SBC B    TW
0017 26 04             BNE      PUNCH2
0019 81 10             CMP A    ##$10
001B 25 02             BCS      PUNCH3
001D 86 0F PUNCH2     LDA A    ##F
001F 4C             PUNCH3   INC A
0020 97 02             STA A    TEMP                STORE BYTE COUNT

      * PUNCH CR, LF, 4 NULLS, S1
0022 CE 00 78          LDH      #TAPE

```

|      |    |    |    |         |                   |                         |                           |  |
|------|----|----|----|---------|-------------------|-------------------------|---------------------------|--|
| 0025 | 8C | 00 | 80 | PDATA   | CPX               | #MTAPE+8                |                           |  |
| 0028 | 27 | 05 |    |         | BEQ               | PUNCH4                  |                           |  |
| 002A | BD | E3 | 87 |         | JSR               | PUN                     | JUMP TO JBUG PUNCH SUBR   |  |
| 002D | 20 | F6 |    |         | BRA               | PDATA                   |                           |  |
| 002F | 96 | 02 |    | * PUNCH | FRAME COUNT       |                         |                           |  |
| 0031 | 8B | 03 |    | PUNCH4  | LDA A             | TEMP                    |                           |  |
| 0033 | 16 |    |    |         | ADD A             | ##3                     |                           |  |
| 0034 | 8D | 2C |    |         | TAB               |                         | INITIALIZE CHECKSUM       |  |
|      |    |    |    |         | BSR               | PTAPE2                  | PUNCH FRAME COUNT         |  |
| 0036 | CE | A0 | 00 | * PUNCH | BEGINNING ADDRESS |                         |                           |  |
| 0039 | 8D | 23 |    |         | LDX               | #PBEGA                  |                           |  |
| 003B | 8D | 21 |    |         | BSR               | PTAPE1                  | PUNCH HIGH BYTE           |  |
|      |    |    |    |         | BSR               | PTAPE1                  | PUNCH LOW BYTE            |  |
| 003D | DE | 00 |    | * PUNCH | DATA              |                         |                           |  |
| 003F | 8D | 1D |    |         | LDX               | TW                      |                           |  |
| 0041 | 7C | A0 | 01 | PUNCH5  | BSR               | PTAPE1                  | PUNCH ONE BYTE (2 FRAMES) |  |
| 0044 | 26 | 03 |    |         | INC               | PBEGA+1                 | INCREMENT PBEGA           |  |
| 0046 | 7C | A0 | 00 |         | BNE               | PUNCH6                  |                           |  |
| 0049 | 7A | 00 | 02 | PUNCH6  | INC               | PBEGA                   |                           |  |
| 004C | 26 | F1 |    |         | DEC               | TEMP                    | DECREMENT BYTE COUNT      |  |
| 004E | DF | 00 |    |         | BNE               | PUNCH5                  |                           |  |
| 0050 | 53 |    |    |         | STX               | TW                      |                           |  |
| 0051 | 17 |    |    |         | COM B             |                         |                           |  |
| 0052 | 8D | 0E |    |         | TBA               |                         |                           |  |
| 0054 | 09 |    |    |         | BSR               | PTAPE2                  | PUNCH CHECKSUM            |  |
| 0055 | 09 |    |    |         | DEX               |                         |                           |  |
|      |    |    |    |         | DEX               |                         |                           |  |
| 0056 | BC | A0 | 04 |         | CPX               | ENDA                    | END ADDRESS ALREADY?      |  |
| 0059 | 26 | B2 |    |         | BNE               | PUNCH1                  | NO                        |  |
| 005B | 7E | E0 | AC |         | JMP               | INIT                    | YES, JUMP TO JBUG CONTROL |  |
| 005E | EB | 00 |    | * PUNCH | 2 HEX             | CHARACTERS              |                           |  |
| 0060 | A6 | 00 |    | PTAPE1  | ADD B             | 0xX                     | UPDATE CHECKSUM           |  |
| 0062 | 36 |    |    |         | LDA A             | 0xX                     | LOAD DATA BYTE IN ACIA    |  |
| 0063 | 8D | 05 |    | PTAPE2  | FSH A             |                         |                           |  |
| 0065 | 32 |    |    |         | BSR               | GUTHL                   | OUTPUT LEFT HEX CHAR      |  |
| 0066 | 8D | 05 |    |         | PUL A             |                         |                           |  |
| 0068 | 08 |    |    |         | BSR               | GUTHR                   | OUTPUT RIGHT HEX CHAR     |  |
| 0069 | 39 |    |    |         | INX               |                         |                           |  |
| 006A | BD | E2 | 9F | OUTHL   | JRS               | \$E29F                  | JUMP TO JBUG SHIFT SUBR   |  |
| 006D | 84 | 0F |    | OUTHR   | AND A             | ##F                     | OUTPUT ONE HEX CHAR       |  |
| 006F | 8B | 90 |    |         | ADD A             | ##90                    |                           |  |
| 0071 | 19 |    |    |         | DAA               |                         |                           |  |
| 0072 | 89 | 40 |    |         | ADC A             | ##40                    |                           |  |
| 0074 | 19 |    |    |         | DAA               |                         |                           |  |
| 0075 | 7E | E3 | 7A |         | JMP               | OUTCH                   | JUMP TO JBUG OUTPUT SUBR  |  |
| 0078 | 0D |    |    | MTAPE   | FCB               | \$0D,\$0A,0x0,0x0,'S',1 |                           |  |
|      |    |    |    |         | END               |                         |                           |  |



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# Dynamic Duo

*Any problem has at least two good solutions—to wit, the following pair of articles addressing the SWTP-Heath H14 interface question. The first uses a modified MP-S board . . .*

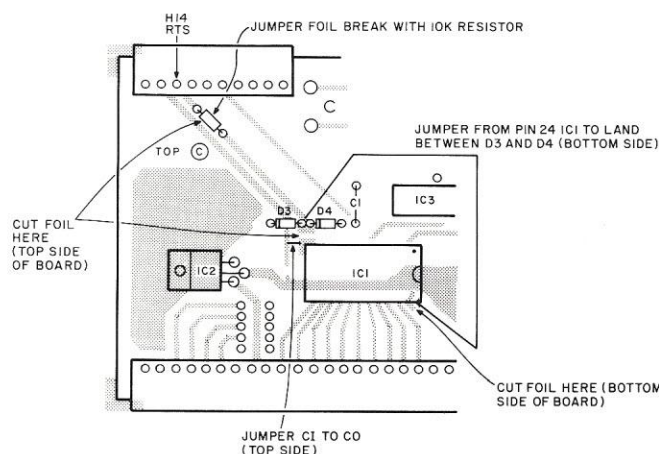


Fig. 1. MP-S board with modifications.

Dr. P. Vijlbrief  
Dept. of Radiology  
University of Leiden  
The Netherlands

SWTP system was quick and easy.

## Modifications

I used an MP-S serial interface board. Only a few small modifications were necessary to handle the handshaking feature of the H14 printer. The RTS (ready to send) signal coming out of the printer should be connected to the I/O card. Therefore, I used the CI connection. I cut the foil between the point where D3 and D4 meet and the connection to the ACIA. The ACIA side of the foil break is jumpered with a small piece of wire to a nearby point on the CO foil to make sure that the clock signal is routed to the ACIA.

I broke the grounding foil coming from pin 24 of the ACIA (CTS) by carefully using a sharp knife, but leaving pin 23 connected to ground. Then I soldered an isolated wire between pin 24 of the ACIA and the joint between D3 and D4. Furthermore, I broke the foil coming from the top board connector point C1 to D3 and D4 and jumpered the break with a 10K Ohm resistor. The modifications are clearly seen in Fig 1. Fig. 2 shows a part of the schematic of the MP-S board, both the original and the modified circuit.

From the H14 interface cable the protective ground (PGND) pin 1 and the signal ground

The popularly priced H14 line printer is a good buy. The kit comes complete—it can be assembled in about 25 hours. The coupling with the popular

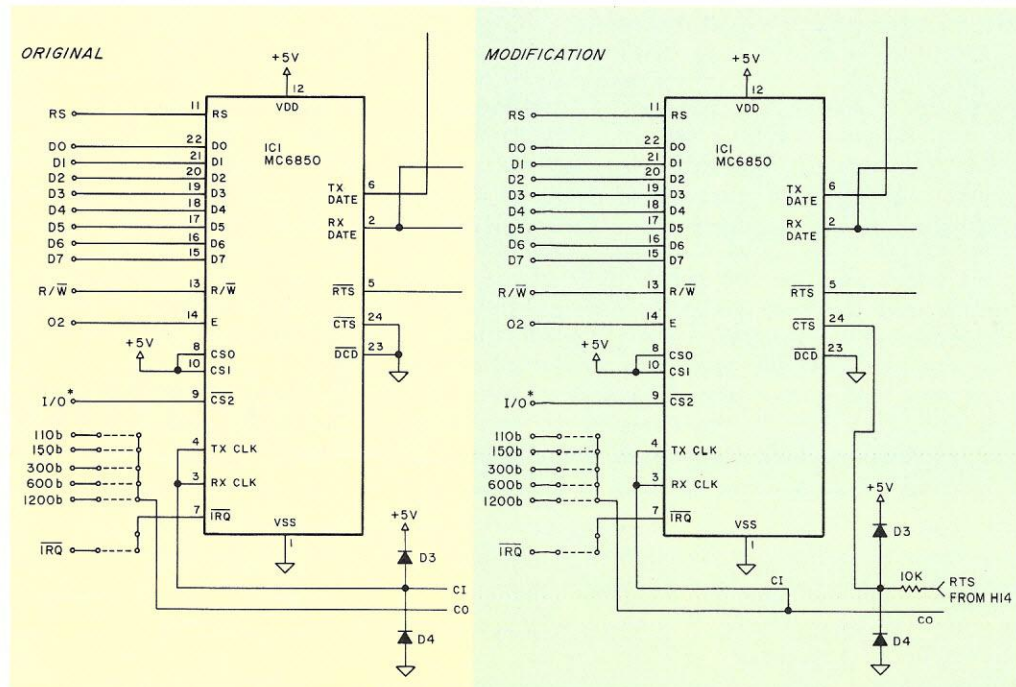


Fig. 2. Detail of MP-S serial interface schematic.



| Hex code | Mnemonic     | Description               |
|----------|--------------|---------------------------|
| 37       | PSH B        | save contents of ACC B    |
| C6 03    | LDA B #\$03  |                           |
| F7 800C  | STA B \$800C | ACIA address              |
| C6 11    | LDA B #\$11  |                           |
| F7 800C  | STA B \$800C |                           |
| 33       | PUL B        | restore contents of ACC B |
| 39       | RTS          | back to main program      |

Example 1. Initialization subroutine for ACIA in port 3.

| Hex code | Mnemonic        | Description                       |
|----------|-----------------|-----------------------------------|
| 37       | PSH B           | save contents of ACC B            |
| FF A060  | STX \$A060      | save contents of X-register       |
| CE 800C  | LDX #\$800C     | load X-register with ACIA address |
| E6 00    | LDA B 0,X       | } check ACIA ready?               |
| 57       | ASR B           |                                   |
| 57       | ASR B           |                                   |
| 24 FA    | BCC CHECK AGAIN | } write contents of ACC A to ACIA |
| A7 01    | STA A 1,X       |                                   |
| FE A060  | LDX \$A060      |                                   |
| 33       | PUL B           | restore contents of ACC B         |
| 39       | RTS             | back to main program              |

Example 2. Subroutine to output contents to ACC A to printer via ACIA in port 3.

(SGND) pin 7 should be connected to the ground point on the MP-S I/O connector. The RS-232C serial input (SIN) pin 3 goes to the RO point on the MP-S I/O connector, and the request to send (RTS) output pin 4 goes to MP-S I/O connector point CI (now CTS). Only RI must be jumpered to ground on the MP-S I/O connector. Do not jumper TI to TC (see Fig. 3).

#### Programs

If you put the MP-S board in I/O port 3 of your SWTP system, you can use the H14 printer without further problems with SWTP 8K BASIC. Jumper the H14 for RS-232C input and output. If you want to use the printer with any other program, you first have to initialize the ACIA in the beginning of the program and then use a typical

ACIA output program to output the contents of ACC A to the printer.

Examples 1 and 2 show the programs I used for the MP-S board in port 3, but you can easily change to other ports by replacing the ACIA address in the program (port 3 address is \$800C).

If you want to change the character width of the printer through software, be careful to load the needed control characters one after another in hex values in ACC A and output them via the output subroutine mentioned earlier. Simply loading the characters in ACIA address + 1 is not the right way to do this because the ACIA has to be checked first.

I hope that you will be as satisfied as I am with the SWTP-Heathkit combination. ■

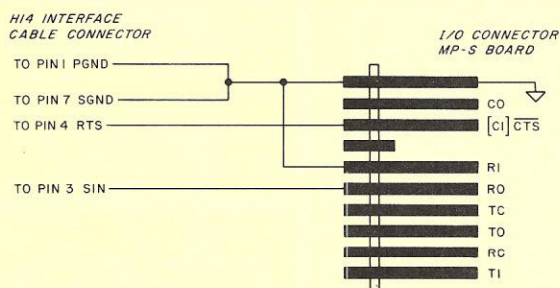


Fig. 3. Interface connection.

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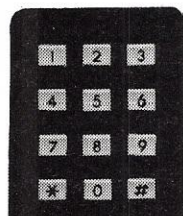
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## Dynamic Duo (cont.)

... while this one describes an entirely home-brew interface.

The Heath H14 Printer is an attractive way of providing hard-copy output at a low cost. Its speed, use of economical standard paper in a range of widths and variety of print densities are a few of the reasons why I chose it for my system. The major drawback is that it is designed to operate with a serial interface at a recommended baud rate of 4800 with special control characters, while most (non-Heath) microcomputers are designed to operate printers from a parallel port with handshaking control signals.

Interfacing the H14 with such a microcomputer can be done in two ways: a parallel input-serial

output port with handshaking control can be constructed; or an ordinary serial port can be used, and the printer driver software routines can be rewritten to recognize the control signals generated by the H14 and respond in the appropriate fashion.

I have used the first approach in interfacing the H14 to a Southwest Technical Products 6800 microcomputer. It has the advantage that it could be applied to almost any microcomputer system, particularly one with a 6821 (or the equivalent 6820) peripheral interface adapter (PIA) as the parallel port. It also requires little or no soft-

ware modification, which may be an important consideration if a source listing for the printer routines is not available.

The second approach, using software, may, in some cases, be simpler where an uncommitted serial port is available and the printer routines can be modified easily.

### Design Details

The SWTP 6800 outputs data to a parallel PIA port by placing it on the bus lines and then sending an active low strobe pulse on CA2 (pin 39 of U1, Fig. 1). When the external device has accepted the data, it responds with a similar low pulse on CA1

(pin 40). These pulses are called "handshaking" signals and are labeled DATA AVAILABLE and DATA ACCEPTED, respectively (see Fig. 2).

A similar protocol is followed in many computers, even if a device other than a PIA is used in the interface. In fact, if you are clever enough, you can substitute other interface hardware such as the 8255 programmable peripheral interface, or even omit the PIA entirely and feed the parallel data bits directly into a universal asynchronous receiver/transmitter (UART, U2).

In my case, omitting the PIA was undesirable because it would have destroyed the software compatibility and plug-in simplicity I wished to preserve. All of the data bus signals to the PIA are shown for the convenience of those using the SS-30 bus, but for other interfaces, you can simply supply the eight data bits and observe the handshaking protocol just outlined.

The data bits go from the PIA to the UART and are strobed in by CA2. A 4800 baud (16 x) clock, which can be found on most computers, operates circuitry internal to the UART to send the data out as a serial stream through pin 25. The clock signal in the 6800 is on the CPU board, and Southwest Tech gives information on how to bring it out on the bus. Transistor Q1 and its associated circuitry convert the TTL voltage levels to RS-232C compatible values.

Before the DATA ACCEPTED pulse can be generated, several things must be true: 1) the UART

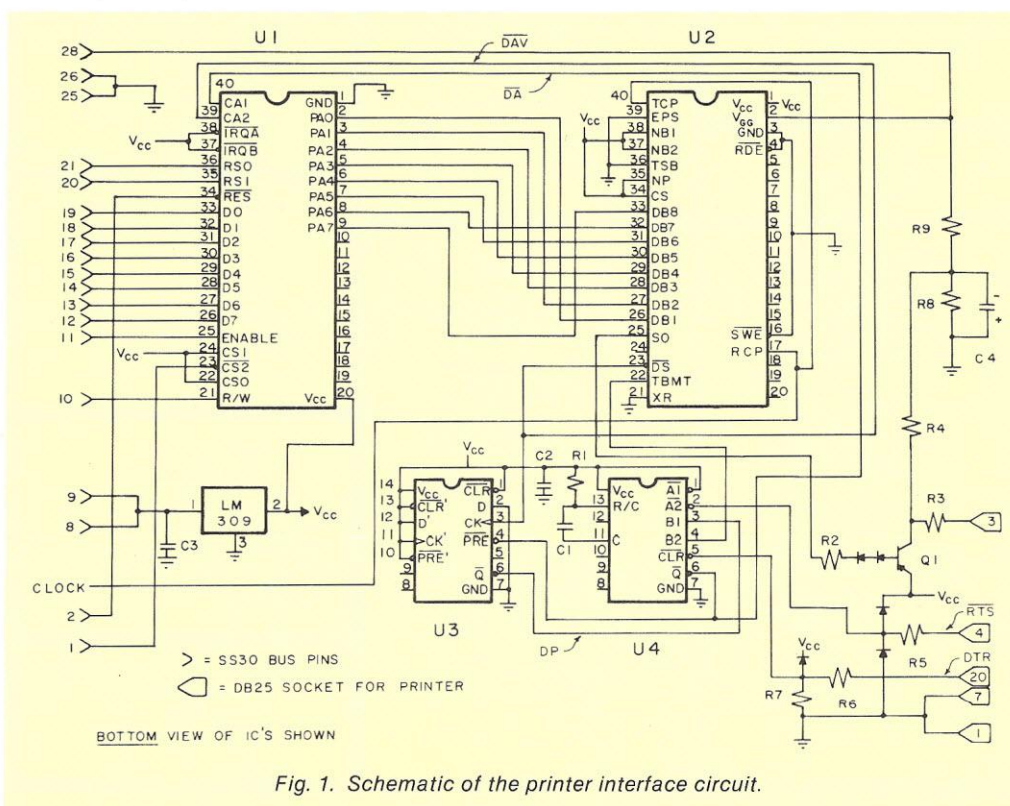


Fig. 1. Schematic of the printer interface circuit.



#### Resistors (all 1/4 W 5 percent)

|        |     |
|--------|-----|
| R1     | 20k |
| R2, R6 | 1k  |
| R3     | 200 |
| R4     | 680 |
| R5     | 2k  |
| R7     | 375 |
| R8, R9 | 430 |

#### Capacitors

|        |         |                   |
|--------|---------|-------------------|
| C1     | 1000 pF | 50 V ceramic      |
| C2, C3 | 0.1 uF  | 50 V ceramic      |
| C4     | 10 uF   | 16 V electrolytic |

#### Diodes

All five diodes are type IN914 or IN4148

#### Transistor

Q1—2N2907

#### Integrated Circuits

|       |                                   |      |
|-------|-----------------------------------|------|
| U1    | —Motorola MC6820 or MC6821        | PIA  |
| U2    | —General Instrument AY-5-1013     | UART |
|       | or Western Digital TR-1602B       |      |
|       | or Texas Instruments TMS6011      |      |
| U3    | —7474 TTL dual D type flip-flop   |      |
| U4    | —74122 TTL retriggerable one-shot |      |
| LM309 | —Voltage regulator, 5 V dc        |      |

Table 1. List of components.

#### Pin Number Description

|     |   |
|-----|---|
| 1,7 | System power and signal grounds, respectively   |
| 3   | Printer data in, RS-232C voltage levels         |
| 4   | RTS, Request to Send Data (active low, RS-232C) |
| 20  | DTR, Data Terminal Ready (active high, RS-232C) |

Table 2. H14 signals used in interface.

transmitter buffer must be empty (signal TBMT); 2) the printer must be "on line" (signal DATA TERMINAL READY, DTR); 3) the data buffer of the printer must not be full (signal REQUEST TO SEND, RTS); and 4) the DATA AVAILABLE pulse must have occurred, clocking the flip-flop in U3 to latch on a high-level DATA PRESENT, DP, signal. The last of these conditions to become true (negative true for RTS) triggers one-shot U4, which sends out the DATA ACCEPTED pulse to CA1. Fig. 2 shows several example cases of each of these signals controlling signal flow.

The only factor that may be critical if you omit the PIA and may differ from one computer to another is the length of this pulse. If it is too narrow, the computer will not see it, and if it is too wide, it may still be present when the computer returns with the next character, causing missing or garbled transmission.

Resistor R1 or capacitor C1 may be changed as necessary to shorten or lengthen the pulse. The values given produce a pulse about seven microsec-

onds wide, which should be more than adequate for all but the slowest of systems. (The values shown should give you some output. If it is garbled, try reducing R1 or C1.)

A careful reader may think that this simple interface has a major flaw, since the first character in a data stream is always transmitted, even if one of the previous four conditions, particularly the printer being "on line," is not met. However, the H14 buffer still accepts characters in the off-line position, so when the on-line button is pushed, printing commences with no lost characters.

There are two conditions that will cause the first character to be lost when the computer tries to print: when the ac power to the printer is off or when the cables connecting printer and computer are unplugged. The additional circuitry needed to correct these rare operator errors did not appear to be justified.

One other point is worth noting: any of these three conditions (printer unplugged, off line

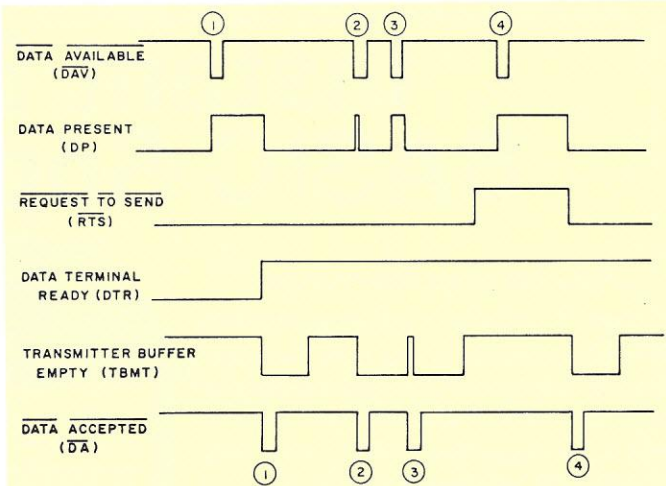


Fig. 2. The data accepted pulse is delayed from the data available pulse as shown for four conditions: 1) DTR initially false (printer off line); 2) no delay, all conditions true; 3) UART buffer full (TBMT false); 4) printer buffer full (RTS false).

or power off) will cause the computer to hang up in a loop waiting for the DATA ACCEPTED pulse, which never comes. In the SWTP 6800, striking Control C on the terminal will have no effect since the terminal port is not interrogated by the CPU until after it receives each expected pulse on the printer port. You should not hit RESET, as this will cause problems reentering the program. Simply put the printer on line and then, while it is printing, if you wish to regain command, type Control C. With these simple caveats, the printer should work perfectly.

The "on line" switch is convenient for temporarily interrupting output (for instance to reposition or replenish paper)

with this interface. When released to the "off line" position, it will suspend operations at the end of the line currently being printed. When it is pressed again, printing resumes.

#### Construction Notes

The prototype model of this interface was constructed on perfboard with point-to-point wiring techniques. Parts placement is not critical, but C2 should be placed close to the supply pins of U3 and U4, and C3 should be close to the voltage regulator input pin. If there is enough interest from readers wishing to copy this interface, I will design and make available a printed circuit board to simplify construction. ■

#### Pin Number Description

|        |  |
|--------|--|
| 1      | A decoded "port select" signal (active low)  |
| 2      | System reset (active low)  |
| 8, 9   | System +8 V dc unregulated power   |
| 10     | Read/write signal (high = read)  |
| 11     | Phase 2 of system clock  |
| 12     | Data bit 7   |
| 13     | Data bit 6   |
| 14     | Data bit 5   |
| 15     | Data bit 4   |
| 16     | Data bit 3   |
| 17     | Data bit 2   |
| 18     | Data bit 1   |
| 19     | Data bit 0   |
| 20, 21 | Address bits A1 and A0, respectively; selects one of four internal PIA registers                               |
| 25, 26 | System power and signal ground   |
| 28     | system -12 V dc (regulated)  |
| Clock  | A clock signal 16X the 4800 baud transmission rate is not available on the bus but must be supplied (see text) |

Table 3. SS-30 bus signals used in interface.



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# Instant Software Inc.

Peterborough, New Hampshire 03458 603-924-7296



# Program Property Rights

---

*Program copyright is still a swamp of confusion. Here's advice on proving authorship.*

---

Joseph G. Wackerman, JD  
3204 Wendover Road  
Troy MI 48064

**T**he protection of your extensive efforts in creating a new program of which you are quite proud has been the subject of attempts to patent programs or segments of programs. The results have produced confusion, to say the least. Clarification is going to take years; but in the meantime, take heart. There is another way to protect your creation. In the field of law, sometimes referred to as idea theft, there is extensive case law giving ownership or property rights to ideas.

A patent, granted by the federal government, gives you ownership or property rights to the device or process. The subject is a physical entity. You own it, you can charge other people for the use of it and no one else can copy it. If the world were perfect, there would be no need for patents. You would be paid for your creativity by those who wished to use what you had developed.

The only reason for a patent is to protect you against unauthorized use—that is, the right to bring a lawsuit to recover for the unauthorized copying of your mechanical device or process.

## Patenting Software—An Overview

The thinking about patenting software has been directed to the program listing. The embodiment of the creative

thought that went into building the program has been thought of as a physically unique thing. For years, there has been a large body of law in the United States recognizing that ideas can also be protected. The thought process is, itself, protected.

If an idea is novel, unique and concrete, the courts will protect the creator in a situation where he has disclosed the idea in confidence or where the idea has been stolen. You do have the right to sue someone who has misappropriated your creativity to his own benefit. As in patent protection, the protection is the right to bring a lawsuit.

Any program listing is concrete. By concrete, I mean something that can be looked at and compared with that which is alleged to have been

stolen. Concrete means that there is no ambiguity or vagueness in the expression of the idea. As everyone is well aware, there is no possibility for vagueness in a program listing.

The novelty or uniqueness of your creation is a question of fact; the novelty and, therefore, the uniqueness need only be in the eye of the user. If the unauthorized use exists, there is almost an admission that the user found this combination of computer expressions to be novel or unique to him. That is all that is needed.

It is not that rare when two minds will perfect the same idea—even at the same time. This does not destroy the uniqueness of any idea. Remember, we are after use in an unauthorized manner only. The important thing to keep in mind

is that you are going after someone to whom you disclosed your idea.

A disclosure in confidence really means that when you showed someone this idea, in the form of a listing, you intended to sell it and were not merely showing off or giving it to the world freely. Presumably, a program of sufficient import to be worth a lawsuit would be of such size and seriousness that disclosure of it would undoubtedly be with the intention of selling it.

To avoid ambiguity before disclosing details, have an agreement that the disclosure is "in confidence" and for the purpose of negotiation. If you are a prospective buyer, you want the disclosure to be "not in confidence." The choice is a business one.

Should a situation ever arise where someone was bold enough to actually steal your program and attempt to benefit commercially from it, there is little doubt that the misappropriation of your work effort would give you the right to sue and recover money. No one is entitled to benefit from someone else's work. In this situation, you do not need all the elements I mentioned above—just prove you wrote it.

## Specifics

So far, the discussion has been in generalities. The particulars of proof of authorship are more interesting. In writing a large program, you will undoubtedly amass a great deal of work papers. If these are dated and saved, they can be used not only to establish that you created the program, but their





sheer volume will go to establishing your effort. Mail the final listing to yourself, but do not open the envelope until the correct moment of the trial. This will give your lawyer fits—which is fun to do.

Of course, the best proof of your authorship would be to have the program announce to the world that you wrote it. On a microcomputer using BASIC, this can be a lot of fun. Programming in that language involves number and letter inputs with number or letter outputs.

As you go through life, there are innumerable number and letter combinations unique to yourself. The first three letters

of your last name and the last two numbers of your street address are your laundry mark. You have social-security numbers, telephone numbers and zip codes, all tied to your life. You also have family members, where, again, you have letters and numbers related uniquely to yourself.

In even the shortest BASIC program, if there are no remarks explaining each line, it is relatively easy to bury in the program a tiny sub-program that can set the value of letter addresses to some number. After the program has been run, you then inquire of those memory addresses what number is

contained in them. For example, my initials are JGW. After a run, if I inquire of one of my programs the numbers in those three addresses, I can produce my birthdate:

P. J. G. W  
12 8 1926

You start with something as simple as

xxx U=6

buried in a working line. Then later,

xx J=U\*2  
xxx W=(J\*100)+(U\*100)

and further down:

xxx U=100:Z=26  
xxx G=4

Finally, at the end of the program:

xxx G=G\*2: W=W+U+Z

With these let statements buried in "working" lines, they can never be found.

On larger mainframes writing in languages less directly related to English, it should be no problem for a programmer to come up with some unique small program that would proclaim the name of the author. For instance, have a line that is not used but calls a second program buried in the listing. The second program prints the name.

Your valuable ideas can belong to you. Keep proof of your authorship and have the fun of hiding your trademark in the bits and bytes! ■

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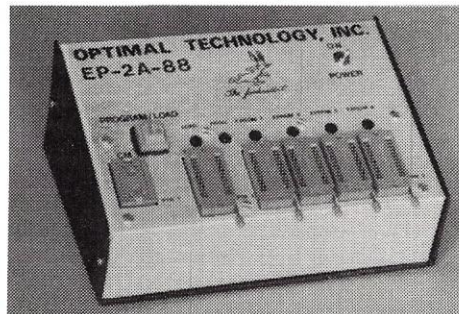
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# PUSH! POP! RAM! WOW!

Use this "quickie" to test your 8080's RAM.

Jack Dennon  
Box G  
Warrenton OR 97146

This program to test 8080 RAM is short, and it works. It is short enough—28 bytes—to toggle in from a switch panel. When I say it works, I mean it has isolated bad 2102s that passed that standby diagnostic test known as "deposit and examine."

This test is based on the 8080's PUSH and POP instructions. Evidently, these instructions place greater demand on memory circuits than do the MOV instructions.

The test starts at a user-specified high memory location and works toward lower memory addresses using a PUSH, PUSH, POP sequence. So load the program above whatever RAM you wish to test. The starting address (actually the first word address plus one) to be tested ap-

pears in the LXI SP instruction at relative locations 05 and 06. The test pattern is in relative location 01. Usually, I start with a pattern of alternate zeros and ones—55 or AA hex—and then if that turns up nothing, I try some other bit patterns.

Since only every other memory byte experiences a write-read sequence in consecutive instruction cycles, it is also worthwhile to try changing the starting address by one byte in the LXI SP instruction.

After the program stops, examine the contents of relative locations 1D and 1E at symbolic location ADDR, where the program deposits the address of the first mismatch. The test pattern is left stored in all tested locations, so by examining the contents of memory in the vicinity of the stop location, you will be able to determine what you have crashed into. It will be either a failed memory location or, if all RAM tested is OK, it will be a natural memory boundary.

In a non-failing, unbounded 64K RAM, the program would self-destruct. Also, with a test pattern of all bits on in a ROM-less system such as my Altair, where nonexistent memory reads out as all bits on, a non-failing memory causes the pro-

gram to wrap its address space and push, push, pop right through itself, so watch out.

Use all bits on only as the last test pattern. The chaos following program destruction is then a sign that your memory is working just fine! ■

```

;      THIS IS AN ACCESS TIME TEST.
;      77/07/02.      J. DENNON.
;
3F00      ORG      3F00H
3F00 3E55      START: MVI      A,55H
3F02 67        MOV      H,A
3F03 6F        MOV      L,A
3F04 31FF3E    LXI      SP,3EFFH
3F07 E5        LOOP:  PUSH     H
3F08 E5        PUSH     H
3F09 E1        POP      H
3F0A BC        CMP      H
3F0B C2123F    JNZ      ERROR
3F0E BD        CMP      L
3F0F CA073F    JZ       LOOP
3F12 210000    ERROR:  LXI      H,0
3F15 39        DAD      SP
3F16 221D3F    SHLD     ADDR
3F19 C3193F    STOP:   JMP      STOP
3F1C 00        NOP
3F1D 0000      ADDR:   DB       0,0
3F1F          END      START
    
```

Program listing.

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# Keeping Real Time with OSI's Superboard II

*A real-time clock, with alarm and timer, for the 6502.*

Recently I purchased a Superboard II from OSI. It is great in many ways, especially in price. But several times I have wished for a clock that could be used to set off an alarm. I have also wanted an interval timer that would provide an interrupt to be used for switching between programs and also to poll my keyboard. Frankly, I didn't want to go to all the trouble and expense of interfacing one of the many clock chips available. The following idea struck me like a bolt out of the blue.

## Hardware Modification

You know, of course, that the 60 Hz power line frequency drives clocks of all kinds. This 60 Hz voltage could be squared up and brought down to TTL levels (i.e., 5 volts) and used to interrupt the 6502's NMI line. On the Superboard II there is an even easier way.

A 60 Hz square wave is generated by a divider chain driven from the clock and is used for

the vertical sync in the video output circuit. To use it, all you need are two pieces of fine wire and one SPST switch. Connect one side of the switch to the 4.7k resistor R10, which pulls up the NMI line to 5 volts and is right in front of the "8" on the keyboard. The exposed lead on this resistor is the NMI interrupt line. Connect the other side of the switch to the C15 output coming from pin 11 on chip U61, which is a 74LS163.

If you follow the printed circuit line from this pin an inch or so toward the front of the Superboard II, you will find a convenient place to which you may solder the other lead from the SPST switch. Be sure to use fine wire for this so as not to pull up the printed circuit lines. See Fig. 1 for a diagram of the circuit.

If you don't have a Superboard II, then you will need to use the 60 Hz power line frequency to drive the NMI interrupt line. Check Don Lancaster's TTL or CMOS cookbooks to learn how to do that.

## The Program

The hardware is easy, and the software is almost as easy. The Superboard II NMI interrupt jumps out to \$0130. The memory

from \$0130 to \$01C0 is unused, so I put my little clock routine there (see program listing). Since an interrupt occurs every 1/60th of a second, we merely have to count these and increment a clock located at \$F0-\$F2 every second. The timer counter is located at \$EF and is decremented every 1/60th of a second until zero is reached. At that point a timer-finished routine is called.

The clock time is displayed on the video screen at location \$D3F0 every second. This puts it right at the bottom of the CRT screen on the Superboard II and below the scrolling point so that it does not interfere with the BASIC output routines. If you don't have a Superboard II you can put the output wherever your video memory is located. Every second, the time on the clock is compared with the time set in the alarm at location \$F4-\$F6. When the two are equal, an alarm routine is called.

To use this program on the Superboard, you merely have to get into monitor mode, load the program beginning at \$0130, set the alarm for whatever time you want, set the clock for the time of day, load your timer-finished routine and your alarm routine and then flip the switch to turn

on the NMI interrupts. Note that the clock and the alarm times are in decimal. They are set with hours in the lowest byte, minutes in the next byte and seconds in the highest byte.

If you don't want the alarm just store a time in it that never occurs in real life such as FF/FF/FF. If you don't want the timer just store a 0 in the timer counter and it will not time out. Note also that you can make this a 24-hour clock by merely changing the instructions at \$0154 and \$0158 to CMPIM \$24 and LDAIM 0, respectively.

## Applications

Use the timer to check the position of a joystick for your fancy game program. This will enable the computer to spend the time in between checks computing movements of the ball or spaceship. Also, you might let the timer routine move the ball or tank, etc., on the CRT screen. Then you can change the speed of the game by merely changing the count with which you set the timer. Since the timer counts down in binary it will interrupt after about 4.4 seconds if set to \$FF initially. That would give you time to take aim.

The timer could also be used to switch between two or three

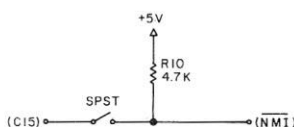


Fig. 1. Circuit diagram.



# Program listing.

```

;Real Time Clock For The 6502
;By Bruce Hoyt
;
ALARM EQU $F4
TMR EQU $EF
CLK EQU $F0
HRS EQU $F0
SEC EQU $F2
CYCLE EQU $F3
VID EQU $D3F0
USRTMR EQU $XXXX
USRALM EQU $YYYY
;
0130 ; ORG $0130
;
0130 48 ; TIME PHA ;Save only A for speed
0131 C6F3 DECZ CYCLE ;One cycle count
0133 D04B BNE CHTMR1 ;If # 0 check timer
0135 8A TXA ;Save X and Y now
0136 48 PHA ;Then update clock
0137 98 TYA
0138 48 PHA
0139 F8 SED ;Decimal mode for clock
013A A93C LDAIM 60 ;Reset 60 cycles
013C 85F3 STAZ CYCLE
013E A202 LDXIM 2
0140 18 INC CLC ;Increment seconds & min
0141 B5F0 LDAZX CLK
0143 6901 ADCIM 1
0145 95F0 STAZX CLK
0147 CA DEX
0148 300A BMI HRSET
014A C960 CMPIM $60
014C D00E BNE DISP
014E A900 LDAIM 0
0150 95F1 STAZX CLK+1
0152 F0EC BEQ INC
0154 C913 HRSET CMPIM $13 ;Handle hours separately
0156 D004 BNE DISP
0158 A901 LDAIM 1 ;One 0'clock
015A 85F0 STAZ HRS
015C A202 DISP LDXIM 2 ;Display as HH:MM:SS
015E A007 LDYIM 7
0160 B5F0 DISP1 LDAZX CLK
0162 208D01 JSR DBYT
0165 A93A LDAIM ':'
0167 99F0D3 STAY VID
016A 88 DEY
016B CA DEX
016C 10F2 BPL DISP1
016E A202 CHALM LDXIM 2 ;Check alarm time out
0170 B5F4 CHALM1 LDAZX ALARM
0172 D5F0 CMPZX CLK
0174 D006 BNE CHTMR ;No? then check timer out
0176 CA DEX
0177 10F7 BPL CHALM1
0179 20YYYY JSR USRALM ;Call your routine
017C 68 CHTMR PLA
017D A8 TAY
017E 68 PLA
017F AA TAX
0180 A5EF CHTMR1 LDAZ TMR ;If TMR already 0
0182 F007 BEQ NOTMR ; then no time out
0184 C6EF DECZ TMR
0186 D003 BNE NOTMR
0188 20XXXX JSR USRTMR ;Call your routine
018B 68 NOTMR PLA
018C 40 RTI
018D 209401 DEYT JSR DEYT1 ;Display byte in A
0190 4A LSRA ; as two ASCII chars
0191 4A LSRA
0192 4A LSRA
0193 4A LSRA
0194 48 DEYT1 PHA
0195 290F ANDIM $0F
0197 0930 ORAIM $30
0199 99F0D3 STAY VID
019C 88 DEY
019D 68 PLA
019E 60 RTS

```

programs all in memory at the same time... as in multitasking. You could put your fancy puzzle solver in the background or your latest PI calculator and run BASIC in the foreground by polling the keyboard every half second or so.

I plan to use the timer to poll the keyboard while I am running some assembly-language programs. That way I can interrupt them when I want to. Hams that have their computer interfaced to their rigs can use the alarm to give automatic station ID every

10 minutes. These are a few of the many uses you may want to try.

In conclusion, I want to point out that though it may seem like this clock routine will take up much of the computer's time, in reality it only uses about .2 percent of the total time! You will never notice the difference unless you are doing some real-time controlling and already driving your 6502 to the limit. But if your 6502 is like mine it spends most of its time waiting! ■

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# You Can't Hurt It by Pressing the Keys

---

*Treat your computer carefully, but don't deprive inquisitive kids of a chance to use it.*

---

**S**ome day I'm going to find an opportunity to adapt and use a line I heard from my uncle years ago. He was a retired army officer of the World War I era; he hunted, fished, raised bird dogs and, late in life, married and became the father of two attractive and well-behaved children. He had little patience with people who complained about the problems of raising children. "My children and my dogs," he said, "come into the world trained."

My own children were born too long ago to learn about microcomputers in their early years, but I'm keeping my uncle's old line polished and ready. Some day there

will be a pause in the brilliant conversation, and though I'll be speaking quietly, everyone in the room will hear me.

"My grandchildren," I'll say, "come into the world knowing BASIC. They learn Pascal before they get into the third grade."

OK, I exaggerate a bit. So did my uncle. But beneath the hyperbole there was a good deal of truth in what my uncle said. His kids could be as wild as the rest, but a quiet word or a lifted eyebrow was all he needed to get them back into line. He never had to wound their dignity with shouts or threats. Come to think of it, he didn't yell at his dogs, either.

## All in the Family

As for those grandchildren I was telling you about: When I got my first computer, a KIM-1, I let them land the moon rocket and hunt the Wumpus and play Hi-Lo.

"You mean you're going to let the kids play with it?" people would say. "Sure," I replied. "You can't hurt it by pressing the keys."

Later I got an OSI Challenger III, with disks and a terminal and a printer. One grandchild is ahead of me in learning BASIC and FORTRAN; he's about 16. One who is six writes letter to her parents using the word processor. One who is three has great fun making lines of different characters using the Repeat key and one character key; he also enjoys playing the beeper with Control G. Others, between three and sixteen, have different degrees of knowledge of BASIC and the operating system, and some are learning a good deal about machine language.

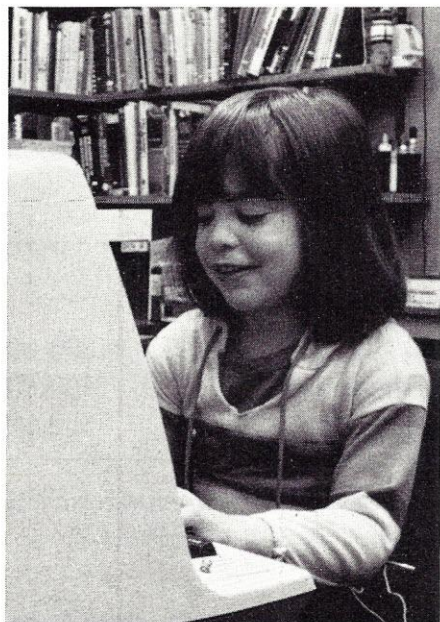
Will they remember tomorrow what they learn today, or are they just playing? There's no way to be sure until tomorrow, I suppose, but I've seen some indications.

The youngest was a few months past her second birthday when I visited her family in Louisiana. One evening her father and I turned over his SWTP to her, and I showed her what would happen if she pressed Control G.

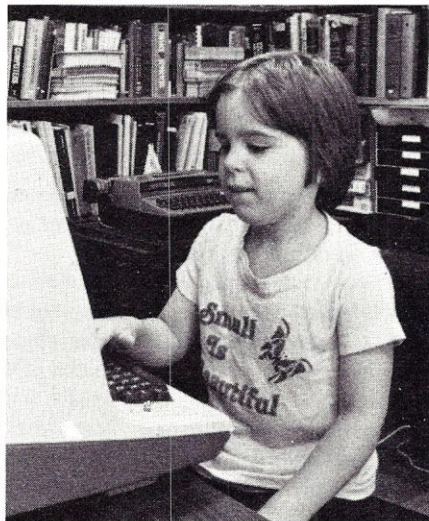
Her father moaned, "You've loosed a monster upon us!" Then I understood why he had not already showed her. Until her bedtime we heard "Beep — beep — beeeeeeeeeep." "Oh, well," I said, "she'll probably forget all about it by tomorrow."

After breakfast the next morning she wanted to "play computer." Five seconds after her mother turned it on I heard the "Beeeeeep."

When the kids started, they were "just playing." The little ones didn't have any idea what any of the keys would do. Now, a few months later, they come to the ter-



*Meg, who had not started the first grade when this picture was made, is a Hangman fan. She reads and spells words of seven or eight letters and often guesses words no one thought she would know.*



*Frank, 4, plays Tictactoe, 23 Matches and a few other games. Using the word processor he writes lines of different letters, beeps the beeper, fills the screen and wipes it clean.*



minal with a pretty good idea what they want to do. More and more, they are able to do it. One eight-year-old gets annoyed because he wrote a BASIC program that has bugs in it; but he keeps at it, gets help from an older brother, and soon has it running.

Later, the five-year-old is in tears. Her sixteen-year-old brother has been on the terminal too long, and she wants to play Hangman (which calls for spelling words I didn't learn until I was in the fourth grade).

We investigate. He has his school computer on line with the acoustic coupler and doesn't want to give up the terminal until he gets his FORTRAN program compiled. Compilation is soon successful, the computer is changed from one system to another, Hangman is called, and the five-year-old again starts trying to identify and spell words that we consider much too hard for her.

I will, of course, have to be careful where and when I use the line I intend to steal from my uncle. One thing is certain: I can't use it at my computer club. Some of the members are not over ten or twelve; several of them seem to have come into the world knowing not only BASIC but also theory and hardware.

Occasionally the professionals in the club wander into some pretty high-level engineering discussions. I understand bits and pieces here and there; some of those ten- to sixteen-year-olds seem to understand most of it and to know what kinds of questions to ask about the rest.

It is absolutely infuriating. But I should have known. When you get right down to it, a smart five-year-old can make the same kinds of decisions a computer makes. To the uninitiated it sounds very complicated: "Compare the X register with the Y regis-



*George gets to use the computer fairly often. Here he defers to his cousin Eric from New Mexico.*

ter: if X is less than Y, increment both X and A; else stop."

A five-year-old, seeing three boxes labeled X, Y and A, can tell whether the Y box has more marbles in it than the X box. He or she can add a marble to the X box and one to the A box, continue until the number in X and Y are equal, and then count the number of marbles in the A box. The computer can do it faster, but not much better for small numbers.

#### Conclusion

The point is that there are a lot of these kids who are going to change the world faster than those of us who are over 30 can even imagine.

The point is that education starts at birth, not in the first grade.

The point is (now that I think of it) maybe the five-year-old doesn't have to be all that smart to understand a computer. Maybe those ten-year-olds who annoy me at club meetings by understanding so much of the technical talk that goes over my head are not geniuses after all. Maybe they're just average kids who had an opportunity to get their hands on the keys.

But more than anything else, I think, the point is that you can't hurt a computer by pressing the keys. If the two-year-old likes to draw pretty lines with it, why shouldn't he or she? ■



*Eight-year-old Cecily likes to write letters on the word processor. Meg keeps an eye on the spelling.*



*While Christopher tries to corner the last Klingon, Eric waits to do some more work on the BASIC program he wrote to encode and decode messages.*



# In Search of MWRITE

*This circuit detects the absence of a front panel and generates MWRITE accordingly.*

Albert S. Woodhull  
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Amherst MA 01002

For a school research project that required a small microcomputer system for experimental control, I assembled a few standard S-100 components in a mainframe without a front panel. I had previously developed a monitor program that allowed me to control such a system with a keyboard; on a prototyping card I built a small EPROM memory to hold the monitor. It all worked fine when I tested it in a mainframe with a front panel, but without the front panel it just wouldn't work.

I eventually figured out that many S-100 memory boards required an MWRITE signal, but that some S-100 CPU cards did not provide this signal. In the

Imsai equipment I was using, the MWRITE signal came from the front panel. It was easy to generate by using an extra gate in one of the support chips on my EPROM card to perform a NOR operation on the  $\overline{\text{PWR}}$  and SOUT lines. However, I wanted to plug my EPROM board into my college's large disk-based system for testing and development. I feared that putting a simple gate on the board could lead to bus conflicts if a front panel did not develop MWRITE in the same way. I needed a circuit that could sense whether a front panel was present on the bus, which could then enable the local MWRITE circuit only when it was needed.

## The Circuit Solution

Fig. 1 shows my solution. The front panels on both the Altair and the Imsai systems into which I might want to insert my EPROM board drive the

PROT and UNPROT lines on the S-100 bus. If the front panel is present, one of these lines is high and the other is low, but in the absence of a front panel both are pulled up by the inputs on the RAM cards. An XOR gate connected to these lines generates a one-level output if a front panel is present and a 0 level output if the panel is absent. I use the output of this gate to inhibit the MWRITE circuit.

circuit.

I offer this not just as a solution to a specific problem, but as an illustration of a situation that may come up when modules are switched around between mainframes. With a little extra hardware or software it is possible to make part of a system sensitive to its environment and capable of different modes of operation in differently configured systems. ■

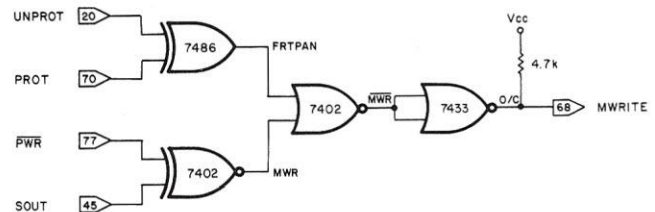


Fig. 1. This circuit allows MWRITE to float if a board (such as a front panel) that develops PROT and UNPROT is present. In many cases, such a board will also normally pull MWRITE low. In a stripped-down system both PROT and UNPROT will float high, and the locally generated MWR is allowed to control the S-100 MWRITE line.

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03 = \*ENTER PURCHASES  
04 = \*ENTER A/C RECEIVABLES  
05 = \*ENTER A/C PAYABLES  
06 = ENTER/UPDATE INVENTORY  
07 = ENTER/UPDATE ORDERS  
08 = ENTER/UPDATE BANKS  
09 = EXAMINE/MONITOR SALES LEDGER  
10 = EXAMINE/MONITOR PURCHASE LEDGER  
11 = EXAMINE/PRINT INCOMPLETE RECORDS  
12 = EXAMINE PRODUCT SALES

## SELECT FUNCTION BY NUMBER

13 = PRINT CUSTOMER STATEMENT  
14 = PRINT SUPPLIER STATEMENTS  
15 = PRINT AGENT STATEMENTS  
16 = PRINT TAX STATEMENTS  
17 = PRINT WEEK/MONTH SALES  
18 = PRINT WEEK/MONTH PURCHASES  
19 = PRINT YEAR AUDIT  
20 = PRINT PROFIT/LOSS ACCOUNT  
21 = UPDATE END MONTH FILES  
22 = PRINT CASH FLOW FORECAST  
23 = ENTER/UPDATE PAYROLL (NOT YET AVAILABLE)  
24 = RETURN TO BASIC

WHICH ONE? (ENTER 1-24)

Each program goes to sub menu, e.g.:  
(9) allows A, LIST ALL SALES; B, MONITOR SALES BY STOCK CODES;  
C, RETRIEVE INVOICE DETAILS; D, AMEND LEDGER FILES;  
E, LIST TOTAL ALL SALES.

Think of the possibilities and add to those here if you wish.

Price for current package Version 1 is \$550, or Version 2 (including aged debtors analysis, etc.) is \$750, or full listing, \$300.

All programs in BASIC for SWTP 6800/Pet 16/32K Systems/Z80 Stroke CPM Systems/Package includes 31 programs

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●●●● Power at your fingertips ●●●●  
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● Comprehensive database management system includes:

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●●●● record create/delete/amend/print 4 ways  
●●●● record sort by any field both alpha or numeric  
●●●● index search or general scan by any field (e.g., town or credit limit)  
●●●● four arithmetic functions to use as calculator on last four fields  
●●●● auto check to prevent double entry with file management system dynamically allocating information for minimum disk space consumption.

● Auto invoice numbering (with override option), plus auto printout integrated with stock and address files for payment term discount, agent allocation, price index retrieval and auto stock update; nominal codes retrieved from address files may be optionally overridden.

● Powerful alternative double entry system providing a bureaux type facility for tracking monthly trading figures and tax accruals.

● Currently using 16 sale and 66 purchase commodity codes which are automatically written into ledgers from address files (includes override option).

● Automatic triple posting of sales/purchases to invoice & general & open item ledgers with complete audit trail to include account verification on payments in/out, so that discrepancies are re-allocated to outstanding accounts. This facilitates part payments.

● Final liquidity strikes a complete audit trail balance with creditors and debtors o/s amounts, bank balances, stock movements, and remaining stock value to give profitability of company.

● Powerful account tracking facilities include auto statement production for all accounts excluding nil balances, with date comparison - current - 30 days - 60 days - 90 days - and appropriate messages when a date block has an inclusion.

● Complete search/create/amend/delete facilities on any significant ledger heading against either open or general ledger in date/invoice/account/agent/nominal code/headings, for full information retrieval such as a shortlist of overdue account for a specified month.

● —NO—special printed stationery needed so your 50-100 invoices cost you a fraction of a penny each, and they are formatted precisely to fit in a standard 'ryman' window envelope for convenient posting. Tracking program enabling printing of past invoices—recall on screen. Plus monitor of specified sales—purchase of commodities by code.

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● Stores up to 2200 addresses or up to 4000 simple ledger records on one diskette with 160K of user menu callable programs from other disk. —Only one program disk—and the hard core programs can't be busted.

● Substantial user group in UK and abroad with all positive feedback implemented every 3/4 weeks and re-distributed free of charge (except cost of disk and mailing 50-70 pounds p.a) so you become part of a commonwealth of users working with an identity of interests.

● This must be surely the most comprehensive, compact, proven, and cost-effective ongoing package on the marketplace at this point in time.

● Total price version 3—475 . . add-on stock option 100 pounds . . add-on bank option . . 100 pounds . . remaining programs 19, 20, 22, 23 jointly 100 pounds.

● Think of just keying in 100 invoices, 50 cheques and going for a walk (provided you left your printer on with paper in). You could leave our programs to do all the secretarial posting automatically, and when you return to set in motion the auto statement run, you can simply post out all paperwork with statements which have done the statement comments for you. . . . .

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# The BASIC Dating Game

---

*You can apply these date-keeping routines to many business applications.*

---

John P. Bauernschub, Jr.  
14809 Clavel Street  
Rockville MD 20853

**T**his article demonstrates some useful software routines that can be applied to many business applications. Dates are common to all business programs. The easier they are to use, the faster these programs will be written and the more reliable they will be.

## The Date Integer

The central idea is to be able to handle the month, day and year in a single variable, called the date integer. Then a few

simple routines can be copied into every program to handle all date manipulations. These routines will accept the date from a terminal, check to determine if it is a valid date, then convert it to a unique number. These routines will also reconstruct the month-day-and-year format and print it in an eight-character field.

There are other benefits to using the date-integer concept in addition to programmer productivity and software reliability. Using a single number instead of three numbers for a date saves valuable disk space. Also, dates can now be handled as simple numbers in arithmetic

statements.

For example, to check if a customer paid his bill within the discount period, just subtract the number of days in the discount period from the date integer for the day payment was received. Then check if that value is less than the date integer of the billing date. In another example with a payroll program, the pay date can be computed just by adding 7 or 14 to the date integer of the last pay date. This date integer saves the programmer from having to check for month or year changes, or even for leap years.

OK, what is the date integer? It is the total number of days since an arbitrary date. For these routines I selected January 1, 1901, as the starting date. Why? Because the century years 1800, 1900 and 2100 are not leap years, but the year 2000 will be. Years evenly divisible by 100 must also be evenly divisible by 400 to qualify as leap years.

So, by starting in 1901, the program was not required to handle these irregularities, and it still has sufficient latitude for today's business applications. You can easily change the starting date (as will be discussed shortly) to an earlier

year and let these century years be leap years.

This looks like another name for the Julian date. True, they both are similar, but the date integer is easier for a programmer to use in arithmetic and comparison routines. This is because he does not have to check if the integer became 78402 or 77963 after adding or subtracting a quantity such as 90 days.

There are two routines in the program listing that convert dates to and from Julian dates using the integer-date routines. They will help you interface existing data files with Julian dates to new programs that use the date integer.

When you use a BASIC interpreter that allows 2-byte integers (you may wish to do this to conserve memory or disk space), the base year should be changed because the maximum positive value for a 2-byte integer is 32,768. This gives a usable span of 89 years. The base year is defined by the variable A5 in line 5030 of the program listing or line 5000 of Program A. The year selected must be a year immediately after a leap year. In such cases, selecting 1961 would be reasonable for most business applications but could not be used for birth dates.

|       |                               |
|-------|-------------------------------|
| A1    | MONTH                         |
| A2    | DAY                           |
| A3    | YEAR                          |
| A4    | COMPUTED DATE INTEGER         |
| A5    | BASE YEAR                     |
| A6    | CONSTANT = 4                  |
| A7    | CONSTANT = 28                 |
| A8    | CONSTANT = 29                 |
| A9    | DATE INTEGER TO BE CONVERTED  |
| X1    | DAYS IN A STANDARD YEAR = 365 |
| X2    | DAYS IN A LEAP YEAR = 366     |
| X3    | DAYS IN FOUR YEARS = 1461     |
| I     | FOR-NEXT INDEX VARIABLE       |
| A(12) | DAYS IN EACH MONTH            |

Table 1. Data dictionary for date-integer routines.



## The Program

The program consists of two sections. The first section demonstrates how to use the integer routines. Ten date-manipulation functions are presented in a menu by the program. The program listing of these functions illustrates how to interface with the date-integer subroutines. The code for each function can easily be located by its title in a REM statement. The program can be stopped by entering a zero for the function selection.

The second section begins at line 3000. It has five subroutines that can be inserted into your programs: Initialization; Date Input; Convert Date to an Integer; Convert Integer to Month, Day, Year; and Print Date from an Integer.

Table 1 lists the variables that are used in these five subroutines. These should be reserved and not used for anything else in your application program. Table 2 gives additional variables that are only used in the demonstration section.

The Initialization routine sets the value of constants for the integer conversion routines. This only has to be run once, provided these variables are not changed elsewhere in your program.

The Date-Input-and-Edit routine prompts for the date to be entered in the month, day, year format. These elements are stored in the variables A1, A2 and A3. If the date is not avail-

able, enter 0,0,0, and the date integer will be set to zero. This will have significance in the print routine.

The input routine leads into the routine to convert the date to the date integer. These values are checked, and error messages are displayed if it is not a valid date. Then the number of days since the base year is computed, and this value is returned in the variable A4.

The fourth routine converts the date integer in the variable A9 to the month, day and year in variables A1, A2 and A3.

The fifth routine also accepts the date integer in the variable A9. If the value is zero, which means that the date is not available, it prints eight blanks to position the printer where it would have been if there had been a date. When the value in A9 is greater than zero, the subroutine is called to convert the date integer to month, day and year. The date is then printed in the format MM/DD/YY.

It is important to always print eight characters, as mentioned before, to position the print head on a report a fixed dis-

tance each time. If your BASIC does not have the PRINT USING command, then line 9100 can be replaced as shown in Example 1 to ensure that the date always occupies eight print positions.

It is easy to use the date-integer routines in your application. At the beginning of your program, initialize the constants with a GOSUB 5000 command. When a date is to be entered from the terminal, execute a GOSUB 6000 command. The computer prompts the operator to enter the month, day, year. If the date entered is invalid, a message will be displayed and the date will be requested again. Try entering 6,31,78 or 2,29,78. The subroutine returns the date in A1, A2 and A3 and the date integer in A4. To display a date, let A9 equal the date integer and execute a GOSUB 9000 command.

The date can be entered in

either of two formats: MM,DD,YY or MM,DD,YYYY. That is, you can enter the year as 79 or 1979. This way, you can enter dates after the year 2000. If the variable A3 has a value less than 100, then 1900 is added to it. See line 7180.

This program was written in a direct BASIC that should run on all but the simplest BASIC interpreters. For that reason it has only one statement per line. Program A lists the date-integer subroutines in a more compact form for Altair Disk BASIC.

All of the A variables are defined as 2-byte integers with the command DEFINT A. Therefore, the INT function is not used. The reverse slash (\) is for integer division, which is much faster than floating point divi-

```
9100 PRINT RIGHT$(STR$(A1),2);"/";RIGHT$(STR$(A2),2);"/";
```

Example 1.

|    |                               |
|----|-------------------------------|
| D  | DATE INTEGER FOR TODAY'S DATE |
| J  | FUNCTION SELECTED             |
| J1 | TEMPORARY STORAGE             |
| J2 | TEMPORARY STORAGE             |
| J3 | TEMPORARY STORAGE             |
| T  | TAB VALUE                     |
| IS | JULIAN DATE INPUT             |

Table 2. Data dictionary for demonstration routines.

```
5000 DEFINT A:DIMA(12):A5=1901:A6=4:A7=28:A8=29:X1=365:X2=366:X3=1461
5010 FOR I=1TO12:READ A(I):NEXT:RETURN
5020 DATA 31,29,31,30,31,30,31,30,31,30,31,30,31
6000 INPUT"DATE";A1,A2,A3
7000 IFA1=0XORA2=0THENPRINT"BOTH MONTH & DAY MUST BE 0 OR NEITHER CAN BE
0... REENTER ";:GOTO6000
7010 IFA1<0ORA1>12THENPRINT"MONTH ERROR... REENTER ";:GOTO6000
7020 IFA2<0ORA2>A(A1)THENPRINT"DAY ERROR... REENTER ";:A(2)=A8:GOTO6000
7030 IFA1=0ANDA2=0THENA3=0:A4=0:RETURN
7040 IFA3<100THENA3=A3+1900
7050 IFA3<A5ORA3>1989THENPRINT"THE YEAR IS INVALID. REENTER ";:GOTO6000
7060 A4=(A3-A5)*X1+(A3-A5)\A6
7070 IFA3-(A3\A6)*A6=0THENA(2)=A8ELSEA(2)=A7:IFA2>A(A1)GOTO7020
7080 IFA1=1GOTO7100
7090 FOR I=1TOA1-1:A4=A4+A(I):NEXT
7100 A4=A4+A2:A(2)=A8:RETURN
8000 A3=(A9-1)\X3:A9=A9-A3*X3:A3=A3*A6+A5:A(2)=A7:I=0:A1=0
8010 IFA9-X1<1GOTO8030
8020 A9=A9-X1:A3=A3+1:I=I+1:IFI<3GOTO8010ELSEA(2)=A8
8030 A1=A1+1:IFA9-A(A1)<1GOTO8040ELSEA9=A9-A(A1):GOTO8030
8040 A2=A9:A(2)=A8:RETURN
9000 IFA9>0THENGOSUB8000ELSEPRINT" ";:RETURN
9010 PRINTUSING"##/";A1,A2;:PRINTRIGHT$(STR$(A3),2);:RETURN
```

Program A. Date-integer routines in compact format.

Program listing.

```
1000 REM THE BASIC DATING GAME
1010 REM
1020 REM WRITTEN BY: JOHN P. BAUERNSCHUB, JR.
1030 REM OCTOBER 25, 1978
1040 REM
1050 GOSUB 5000
1060 PRINT CHR$(26)
1070 LET T=20
1080 PRINT TAB(T);"ENTER TODAY'S ";
```



```

1090 GOSUB 6000
1100 LET D=A4
1110 PRINT
1120 PRINT
1130 IF J>0 GOTO 1240
1140 PRINT TAB(T);"1 - CONVERT DATE TO AN INTEGER"
1150 PRINT TAB(T);"2 - CONVERT AN INTEGER TO A DATE"
1160 PRINT TAB(T);"3 - DAY NUMBER IN THIS YEAR"
1170 PRINT TAB(T);"4 - DAYS-REMAINING THIS YEAR"
1180 PRINT TAB(T);"5 - DATE N DAYS FROM TODAY (+ OR -)"
1190 PRINT TAB(T);"6 - ADD (+ OR -) DAYS TO ANY DATE"
1200 PRINT TAB(T);"7 - NUMBER OF DAYS BETWEEN TWO DATES"
1210 PRINT TAB(T);"8 - DAY IN YOUR LIFE"
1220 PRINT TAB(T);"9 - CONVERT DATE TO JULIAN DATE"
1230 PRINT TAB(T-1);"10 - CONVERT JULIAN DATE TO DATE"
1240 PRINT
1250 PRINT TAB(T);"    SELECT A FUNCTION";
1260 INPUT J
1270 PRINT
1280 IF J=0 THEN STOP
1290 ON J GOSUB 1320,1390,1450,1550,1650,1700,1800,1950,2020,2150
1300 GOTO 1110
1310 REM
1320 REM    CONVERT DATE TO AN INTEGER
1330 REM
1340 PRINT "ENTER THE ";
1350 GOSUB 6000
1360 PRINT A4
1370 RETURN
1380 REM
1390 REM    CONVERT INTEGER TO A DATE
1400 REM
1410 INPUT "ENTER THE INTEGER";A9
1420 GOSUB 9000
1430 RETURN
1440 REM
1450 REM    DAY NUMBER IN THIS YEAR
1460 REM
1470 LET A9=D
1480 GOSUB 8000
1490 LET A1=1
1500 LET A2=1
1510 GOSUB 7000
1520 PRINT "TODAY IS DAY NUMBER";D-A4+1;"IN";A3
1530 RETURN
1540 REM
1550 REM    DAYS REMAINING THIS YEAR
1560 REM
1570 LET A9=D
1580 GOSUB 8000
1590 LET A1=12
1600 LET A2=31
1610 GOSUB 7000
1620 PRINT "THERE ARE";A4-D;"DAYS REMAINING THIS YEAR"
1630 RETURN
1640 REM
1650 REM    COMPUTE A DATE FROM TODAY
1660 REM
1670 LET J1=D
1680 GOTO 1750
1690 REM
1700 REM    COMPUTE A DATE FROM ANY DATE
1710 REM
1720 PRINT "ENTER THE ";
1730 GOSUB 6000
1740 LET J1=A4
1750 INPUT "ENTER NUMBER OF DAYS TO BE ADDED (+ OR -)";J2
1760 LET A9=J1+J2
1770 GOSUB 9000
1780 RETURN
1790 REM
1800 REM    NUMBER OF DAYS BETWEEN TWO DATES
1810 REM
1820 PRINT "ENTER THE EARLIER ";
1830 GOSUB 6000
1840 LET J1=A4
1850 PRINT "ENTER THE LATER ";
1860 GOSUB 6000

```

```

1870 PRINT "THERE ARE";A4-J1;"DAYS BETWEEN ";
1880 LET A9=J1
1890 GOSUB 9000
1900 PRINT " AND ";
1910 LET A9=A4
1920 GOSUB 9000
1930 RETURN
1940 REM
1950 REM    COMPUTE THE DAY IN YOUR LIFE
1960 REM
1970 PRINT "ENTER YOUR BIRTH";
1980 GOSUB 6000
1990 PRINT "THIS IS DAY NUMBER";D-A4+1;"IN YOUR LIFE"
2000 RETURN
2010 REM
2020 REM    CONVERT DATE TO JULIAN DATE
2030 REM
2040 PRINT "ENTER THE ";
2050 GOSUB 6000
2060 LET J1=VAL(RIGHT$(STR$(A3),2))*1000
2070 LET J3=A4
2080 LET A1=1
2090 LET A2=1
2100 GOSUB 7000
2110 LET J2=J1+J3-A4+1
2120 PRINT J2
2130 RETURN
2140 REM
2150 REM    CONVERT JULIAN DATE TO DATE
2160 REM
2170 INPUT "ENTER THE JULIAN DATE (YYDDD)";I$
2180 LET J1=INT(VAL(I$)/1000)+1900
2190 IF J1>A5 THEN GOTO 2220
2200 PRINT "THE YEAR CANNOT BE BEFORE ";A5
2210 GOTO 2150
2220 LET A1=1
2230 LET A2=1
2240 LET A3=J1
2250 GOSUB 7000
2260 LET J2=VAL(RIGHT$(I$,3))
2270 IF J2<1 THEN GOTO 2310
2280 LET J3=X1
2290 IF J1/4=INT(J1/4) THEN J3=X2
2300 IF J2<=J3 THEN GOTO 2330
2310 PRINT "DAY ERROR... RE";
2320 GOTO 2150
2330 A9=A4+J2-1
2340 GOSUB 9000
2350 RETURN
2360 REM
2370 REM
3000 REM    * * * * *
3010 REM
3020 REM    DATE INTEGER ROUTINES
3030 REM
3040 REM    * * * * *
3050 REM
5000 REM    I N I T I A L I Z A T I O N
5010 REM
5020 DIM A(12)
5030 LET A5=1901
5040 LET A6=4
5050 LET A7=28
5060 LET A8=29
5070 LET X1=365
5080 LET X2=366
5090 LET X3=1461
5100 FOR I=1 TO 12
5110 READ A(I)
5120 NEXT I
5130 DATA 31,29,31,30,31,30,31,31,30,31,30,31
5140 RETURN
5150 REM
6000 REM    DATE INPUT
6010 REM
6020 INPUT "DATE (M,D,Y)";A1,A2,A3
6030 REM
7000 REM    CONVERT DATE TO INTEGER

```





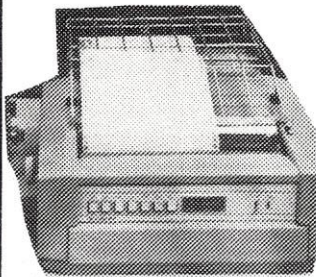
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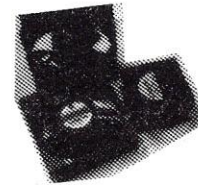
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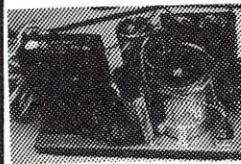
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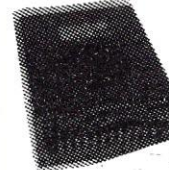
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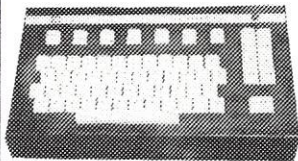
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16V at 6 Amp  
6V at 2 Amp

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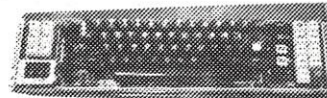
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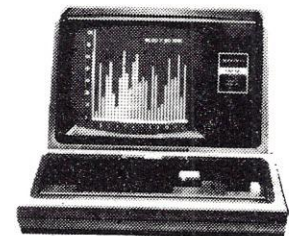
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```

7010 REM INPUT DATA IS IN A1, A2, A3
7020 REM RETURNS DATE INTEGER IN A4
7030 REM
7040 REM
7050 IF A1<0 THEN GOTO 7310
7060 IF A1>12 THEN GOTO 7310
7070 IF A2<0 THEN GOTO 7330
7080 IF A1>0 THEN GOTO 7130
7090 IF A2>0 THEN GOTO 7140
7100 LET A3=A5
7110 LET A4=0
7120 GOTO 7290
7130 IF A2>0 THEN GOTO 7170
7140 PRINT "BOTH MONTH & DAY MUST BE ZERO OR NEITHER CAN BE ZERO..."
7150 PRINT "REENTER ";
7160 GOTO 6020
7170 IF A2>A(1) THEN GOTO 7330
7180 IF A3<100 THEN LET A3=A3+1900
7190 IF A3<45 THEN GOTO 7360
7200 LET A4=(A3-A5)*X1+INT((A3-A5)/A6)
7210 LET A(2)=A7
7220 IF A3-INT(A3/A6)*A6=0 THEN LET A(2)=A8
7230 IF A2>A(1) THEN GOTO 7330
7240 IF A1=1 THEN GOTO 7280
7250 FOR I=1 TO A1-1
7260 LET A4=A4+A(I)
7270 NEXT I
7280 LET A4=A4+A2
7290 LET A(2)=A8
7300 RETURN
7310 PRINT "MONTH ERROR... REENTER ";
7320 GOTO 6020
7330 PRINT "DAY ERROR... REENTER ";
7340 LET A(2)=A8
7350 GOTO 6020
7360 PRINT "THE YEAR CANNOT BE BEFORE ";A5;" REENTER ";
7370 GOTO 6020
7380 REM
7390 REM
7400 REM
7410 REM
7420 REM
7430 REM
7440 REM
7450 REM
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7500 REM
7510 REM
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7880 REM
7890 REM
7900 REM
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7930 REM
7940 REM
7950 REM
7960 REM
7970 REM
7980 REM
7990 REM
8000 REM
8010 REM
8020 REM
8030 REM
8040 REM
8050 REM
8060 LET A3=INT((A9-1)/X3)
8070 LET A9=A9-A3*X3
8080 LET A3=A3*A6+A5
8090 LET A(2)=A7
8100 LET I=0
8110 LET A1=0
8120 IF A9-X1<1 THEN GOTO 8180
8130 LET A9=A9-X1
8140 LET A3=A3+1
8150 LET I=I+1
8160 IF I<3 THEN GOTO 8120
8170 LET A(2)=A8
8180 LET A1=A1+1
8190 IF A9-A(1)<1 THEN GOTO 8220
8200 LET A9=A9-A(1)
8210 GOTO 8180
8220 LET A2=A9
8230 LET A(2)=A8
8240 RETURN
8250 REM
8260 REM
8270 REM
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8920 REM
8930 REM
8940 REM
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8960 REM
8970 REM
8980 REM
8990 REM
9000 REM
9010 REM
9020 REM
9030 REM
9040 IF A9=0 THEN PRINT "
";
9050 IF A9=0 THEN RETURN
9060 GOSUB 8000
9070 REM
9080 REM
9090 REM
9100 PRINT USING "##/"/:A1:A2;
9110 PRINT RIGHT$(STR$(A3),2);
9120 RETURN

```

sion. This code should also work on Radio Shack Level II BASIC. Program A can be used with the demonstration routines without any changes since the same variables and

subroutine entry points are used.

Dates can be awkward to use. However, with a little standardization, a programmer can handle them with confidence. ■

#### Sample run.

ENTER TODAY'S DATE (M,D,Y)? 10,25,78

- 1 - CONVERT DATE TO AN INTEGER
- 2 - CONVERT AN INTEGER TO A DATE
- 3 - DAY NUMBER IN THIS YEAR
- 4 - DAYS REMAINING THIS YEAR
- 5 - DATE N DAYS FROM TODAY (+ OR -)
- 6 - ADD (+ OR -) DAYS TO ANY DATE
- 7 - NUMBER OF DAYS BETWEEN TWO DATES
- 8 - DAY IN YOUR LIFE
- 9 - CONVERT DATE TO JULIAN DATE
- 10 - CONVERT JULIAN DATE TO DATE

SELECT A FUNCTION? 1

ENTER THE DATE (M,D,Y)? 10,25,78  
28422

SELECT A FUNCTION? 2

ENTER THE INTEGER? 28422  
10/25/78

SELECT A FUNCTION? 3

TODAY IS DAY NUMBER 298 IN 1978

SELECT A FUNCTION? 4

THERE ARE 67 DAYS REMAINING THIS YEAR

SELECT A FUNCTION? 5

ENTER NUMBER OF DAYS TO BE ADDED (+ OR -)? 45  
12/ 9/78

SELECT A FUNCTION? 6

ENTER THE DATE (M,D,Y)? 12,10,78  
ENTER NUMBER OF DAYS TO BE ADDED (+ OR -)? 70  
2/18/79

SELECT A FUNCTION? 7

ENTER THE EARLIER DATE (M,D,Y)? 4,15,78  
ENTER THE LATER DATE (M,D,Y)? 5,6,78  
THERE ARE 21 DAYS BETWEEN 4/15/78 AND 5/ 6/78

SELECT A FUNCTION? 8

ENTER YOUR BIRTHDATE (M,D,Y)? 5,8,1953  
THIS IS DAY NUMBER 9302 IN YOUR LIFE

SELECT A FUNCTION? 9

ENTER THE DATE (M,D,Y)? 10,25,78  
78298

SELECT A FUNCTION? 10

ENTER THE JULIAN DATE (YYDDD)? 80060  
2/29/80

SELECT A FUNCTION? 0

BREAK IN 1270  
OK



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✓ 279

The Journal for Progressive Computing.™

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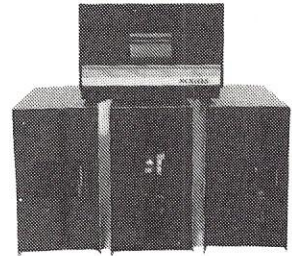
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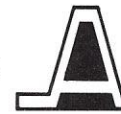
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# You Name It!

---

*If you're one of those people who have trouble with memory (remembering names), here's a program that allows you to devise your own five-letter names for things.*

---

```
1 REM **NAME IT!** BY GARY SABOT
10 REM ONLY 20 CONSONANTS ARE USED SINCE Q IS OMITTED
30 RANDOM
40 DIM C(3), V(3)
50 REM LINE 51 CAUSES A NEW PAGE TO BE GENERATED
51 PRINT CHR(5);
60 LET A$="AEIOU"
70 LET B$="BCDFGHJKLMNPRSTVWXYZ"
80 LET C=1
90 PRINT "HOW MANY RANDOM WORDS DO YOU WANT";
100 INPUT G
110 FOR B=1 TO G
120 REM RANDOM ROUTINE TO DETERMINE WHICH
130 REM CHARACTERS WILL BE PRINTED
140 FOR K=1 TO 3
150 LET V(K)=INT(5*RND(0))+1
160 LET C(K)=INT(20*RND(0))+1
170 NEXT K
180 REM WORD PRINTING ROUTINE
190 PRINT MID(B$,C(1),1);MID(A$,V(1),1);
200 PRINT MID(B$,C(2),1);MID(A$,V(2),1);
210 PRINT MID(B$,C(3),1);" ";
220 REM ROUTINE TO FORMAT PRINTOUT TO 7 WORDS/LINE
230 LET C=C+1
240 IF C > 7 THEN 260
250 GOTO 280
260 PRINT
270 LET C=1
280 NEXT B
290 END
```

Fig. 1. Program listing.

**T**he following program arose from the need to name a parakeet I had just purchased. I had heard about this sort of program before, and since I couldn't find an actual copy of it, I decided to write it myself.

## A Basic Explanation

This program is designed to print out five-letter words. The first, third and fifth letters are consonants, while the second and fourth are vowels.

Lines 30 through 80 are used to initialize variables and to store the vowels and consonants in strings A\$ and B\$, respectively. I only used 20 consonants, leaving the q out. This was because, in English, q is almost always followed by u, while in my program it quite often wasn't, and it caused many unpronounceable combinations.

Lines 90 and 100 are used



to determine how many words the user wants. Lines 110 through 290 form the main loop of the program, which is repeated once for each word to be printed.

Line 150 is used to fill an array, V, which is dimensioned to 3, with random numbers from 1 to 5. These numbers will later be used to determine which of the five vowels to print in the two spaces allotted for them. One of the spots in the array is not used in the printing. Line 160 fills a similar array, C, with random numbers from 1 to 20 for each of the 20 consonants.

Lines 190 through 210 print the word that has been computed with the random numbers. In the BASIC that I was using, the MID statement, which is employed in the printing routine, is used as follows: The statement MID(Z\$,A,B) would mean print a substring of Z\$, starting at character A, and for a

length of B characters. After the word has been printed, four spaces are printed to separate the words.

Lines 230 through 280 are used to format the words into seven words per line. This ensures that in a standard 64-character line, none of the

words will be chopped in half, leaving two letters on one line and three on another, for example. If your computer has a different line length, just change the 7 in line 240 to the number of words that your computer can fit on a line, and the

program will take care of the rest. Fig. 1 shows the program, and Fig. 2 shows a sample run.

By the way, my parakeet's name is "Holmes" (I added an l to the word "homes," which is what the computer actually provided). ■

RUN

HOW MANY WORDS DO YOU WANT? 35

VOLEG GAZEL TENAN ROZAR ZANEZ TOJEK BAHEN

WETAL RUXEZ CABUH GEJEJ POZIS LODAR SILEL

HEJEH RIBUY SOMUG RULOB CIFUW VOTIX WILEV

YUZOZ DELOW ZUCOP FAMUV REJEY ZUTUH RUSAF

JEBUY GAWER KAHUX BEWAP NARAL VUYON LADEL

Fig. 2. Sample run.

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| SORT | 32K                  | 49                 | SORT     | 680K                 | 2569               |
| SORT | 85K                  | 173                | SORT and | 85K SORT +           | 1757               |
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  - 2 Push Buttons for time set
  - 2 Toggle Switches for alarm
  - 1 Filter cap
  - 4 1N4000 series diodes
  - 1 1N4148
  - 2 Disc caps
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# Cut 'Em off at the Pass!

*Looking for something light in Level I? You'll like this a lot.*

Richard A. Rodman  
1727 Cy Court  
Vienna VA 22180

**H**ere's a fun game in Level I BASIC that demonstrates the graphics capabilities of the TRS-80. It could be modified to run on almost any machine with graphics. Two can play; the computer is a passive participant.

Each player has a dot that moves on the screen leaving a trail behind it. He must avoid striking or passing over any of the old trails. The object is to cut off the other player so he cannot find any open space.

Each player, on his turn, types U, D, L or R to indicate in which direction he wants to move. Then, his dot will move a random distance up to ten

spaces. The upper line of the display is saved for user prompts; the remainder of the screen is the playing field. If you go off any side, you'll reappear on the opposite side.

Astute video-game fanatics will recognize that this game is similar to the Atari game "Surround" and the G. I. Gimini game "Barricade." However, the nonreal-time operation in BASIC makes a great difference.

The game is quite simple and, since it's in BASIC, lends itself to easy modification. It's only about 1132 bytes long. One possible modification would be the addition of extra blocks, walls or other obstacles... or add secret passageways that cause players to disappear and reappear somewhere else!

Notice the statements around line 1000. These

add/subtract M to/from X/Y. If M=1, the trails are solid. Making M more than one will

give a "spaced out" effect. All of my friends who played this game liked it a lot! ■

CLS: Clear screen.  
R.(N) or RND(N): Random function; if N>0, returns an integer from 1 to N.  
SET(X,Y): Turn on the bit at X,Y (make it white).  
RESET(X,Y): Turn off the bit at X,Y (make it black).  
POINT(X,Y): Returns 1 if X,Y is on, 0 if it is off.  
P.: Print.  
P.AT 0: Print on the first line.  
G.: GOTO.  
GOS.: GOSUB.  
F.: FOR.  
T.: THEN.  
IN.: INPUT.  
N.: NEXT.  
RET.: RETURN.

*Table 1. Abbreviations have been used in this program. These abbreviations are particular to the TRS-80, so an explanation of what they stand for is included for Poly 88 users and others who may want to use this program.*

```

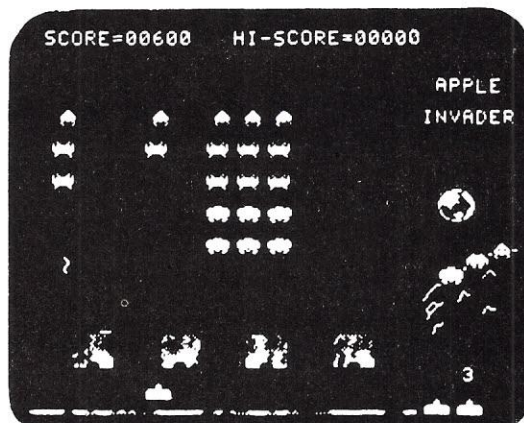
1 CLS:P."CUT 'EM OFF AT THE PASS!"
2 P.:P."TO GO: ↑ ↓ ← →"
3 P. "TYPE: U D L R"
4 P.:P."WHEN I TELL YOU IT'S YOUR TURN, TYPE ONE OF THOSE FOUR"
5 P."LETTERS. SORRY, NO TYPING ERRORS ALLOWED!"
6 P.:P."THE OBJECT OF THIS GAME IS TO AVOID RUNNING INTO ANY OF THE"
7 P."OLD TRACKS. YOU'LL SEE WHAT I MEAN!"
8 P.
10 IN."WHO IS THE PLAYER ON THE LEFT";A$
15 IN."AND WHO IS ON THE RIGHT";B$
20 U=1:D=2:R=3:L=4:Q=0:CLS
25 M=1:REM MOVE INCREMENT
30 N=10/M:REM MOVE LIMIT
35 A=30:I=25:C=90:G=25:SET(A,I):SET(C,G)
100 REM FIRST PLAYER GOES
110 P.AT 0,A$;:IN.E:H=RND(N)
120 X=A:Y=I:GOS.1000
125 A=X:I=Y
130 IF Q=0 G. 210
140 P.AT 0,"SORRY,";A$:G.10
200 REM SECOND PLAYER GOES
210 P.AT 0,B$;:IN.E:H=RND(N)
220 X=C:Y=G:GOS.1000
225 C=X:G=Y
230 IF Q=0 G. 110
240 P.AT 0,"SORRY,";B$:G. 10
1000 F.T=1 TO H:REM THIS ROUTINE MOVES THE DOT
1005 ON E G. 1010,1020,1030,1040
1010 Y=Y-M:G. 1050
1020 Y=Y+M:G. 1050
1030 X=X+M:G. 1050
1040 X=X-M
1050 IF X<0 T. X=X+128:REM NORMALIZE
1060 IF Y<3 T. Y=Y+45
1070 IF X>127 T. X=X-128
1080 IF Y>47 T. Y=Y-45
1100 Q=Q+POINT(X,Y):SET(X,Y)
1110 N.T
1115 P.AT 0," ";
1120 RET.
1130 END
    
```

*Program listing.*



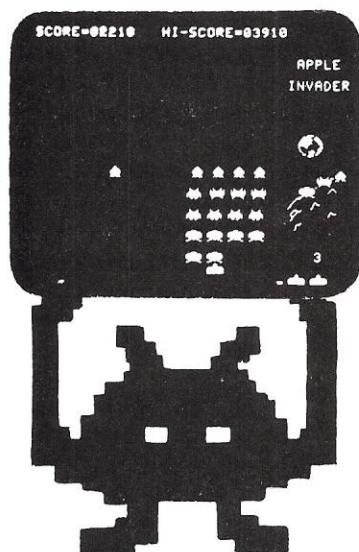


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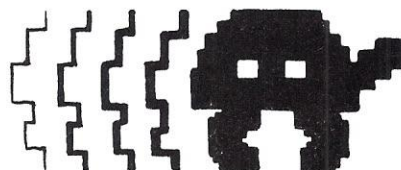
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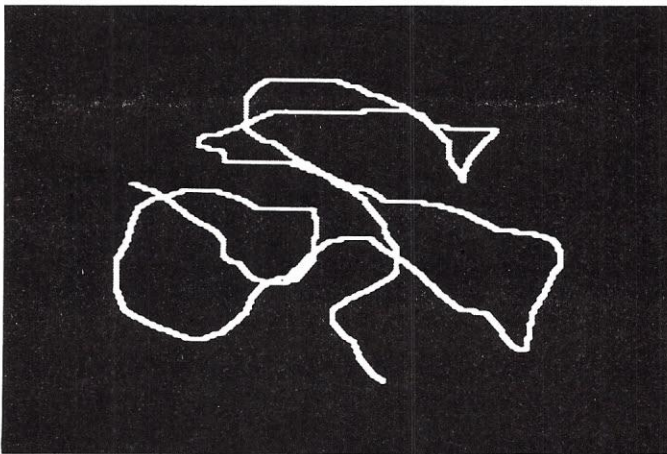
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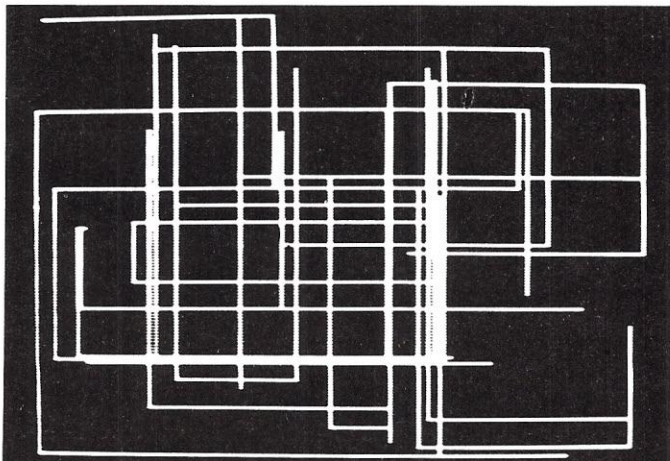


# An Easy Way to Apple Hi-Res Graphics

*Assembly language is not needed for high-resolution graphics on the Apple II.*



*Example of Hi-Res Sketch subprogram using Apple II's game paddles.*



*Example of Random Verticals and Horizontals program.*

```
8199 REM ...GOSUB WIPE TO CLEAR SCREEN BY PUSHING PADDLE BUTTON.
8200 IF PEEK (-16287)>127 OR PEEK (-16286)>127 THEN CALL CLEAR
```

*Fig. 1.*

Malcolm J. R. Clark  
336 Foul Bay Road  
Victoria, British Columbia  
Canada V8S 4G7

As soon as my 16K Apple II arrived, I was rather keen to get going with the high-resolution graphics, but I soon discovered that I would need to learn to program in assembler. However, the Hi-Res demo cassette the Apple people supplied had a machine-language program all ready to go, followed by a BASIC program that interacted with the first program. Therefore, what could be easier than loading only the machine-language program, followed by a different BASIC program of

one's own devising within the limited unused memory available?

The program listing shows the substitute BASIC program I prepared to interact with the Hi-Res machine language. This program contains four subprograms: one to allow free-hand drawing with the game paddles, one to draw random horizontal and vertical lines, one to sketch the starship Enterprise with zoom and, last but not best, Clark's Art Gallery. All four take advantage of the fun involved in watching the computer draw a shape a line at a time as opposed to the opposite strategy of flashing up a drawing apparently instantaneously. Please keep in mind that the program assumes the game paddles are plugged in, the machine-language program loaded and HIMEM set. The accompanying photographs show several example plots.

The Sketch subprogram surprised me with occasional erratic results, and it turned out that the two game paddles were not independent. To illustrate this, key and run the program

```
2 PRINT PDL(0), PDL(1): GOTO 2
```

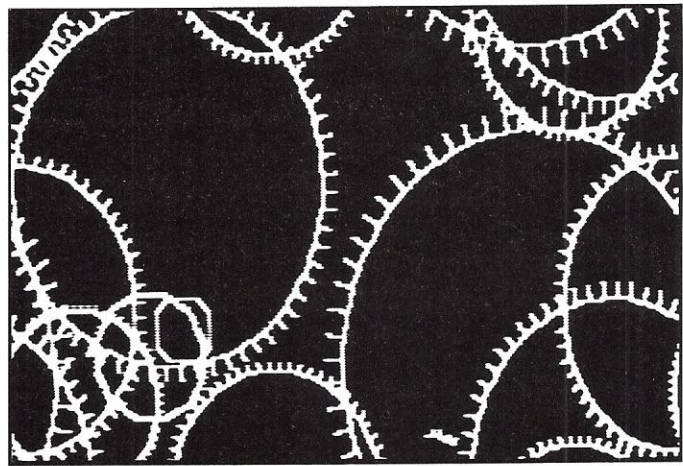
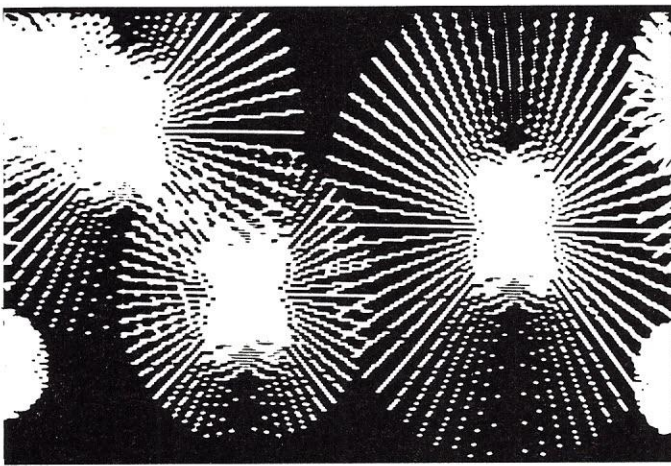
and alternately change the settings of one paddle, then the other. Table 1 shows an example of PDL(1) values changing, though only PDL(0) was manipulated. For the two Apples I've tried this on, it seems worse for high settings of PDL(1).

You'll see another surprise if you take a look at statement

| PDL(0) | PDL(1) |
|--------|--------|
| 119    | 15     |
| 111    | 50     |
| 96     | 33     |
| 80     | 71     |
| 69     | 59     |
| 65     | 77     |
| 65     | 76     |
| 65     | 77     |
| 65     | 77     |
| 65     | 76     |
| 65     | 78     |
| 65     | 77     |
| 66     | 72     |
| 70     | 86     |
| 73     | 71     |
| 77     | 55     |
| 80     | 72     |
| 84     | 54     |
| 86     | 46     |
| 87     | 41     |

*Table 1. Example printout for statements "2 PRINT PDL(0), PDL(1): GOTO 2." Only paddle 0 was manipulated.*





Examples from Clark's Art Gallery.

### Program listing.

```

10 REM ...SOME EXAMPLES OF HIGH RESOLUTION GRAPHICS PROGRAMS IN AP
  PLE II INTEGER BASIC"
20 REM ....M. J. R. CLARK.....1978
30 REM : LOAD THE MACHINE LANGUAGE PROGRAM FROM APPLE'S HIGH-RES DE
  NO TAPE BEFORE LOADING THIS.
40 REM *****REMEMBER TO SET HINEM *****
100 INIT=3072: CLEAR=3086: POSN=3761: PLOT=3780: LINE=3786: POINT=8000
  : FIRST=8100: WIPE=8200: KEY=8300: TELL=8360
101 SHAPE=3805
110 DIM E(56), C(4), Y$(1)
130 W=255: C(1)=W: REM ...WHITE
140 V=170: C(2)=V: REM ...VIOLET
150 G=85: C(3)=G: REM ...GREEN
160 B=0: C(4)=B: REM ...BLACK
1000 POKE -16303,0: CALL -936
1010 PRINT ".....HIGH RESOLUTION GRAPHICS.....": PRINT
1020 PRINT "PROGRAMS IN APPLE II INTEGER BASIC"
1030 PRINT : PRINT "MACHINE LANGUAGE PROGRAM FROM APPLE'S HIGH-RESO
  LUTION DEMO TAPE MUST BE LOADED PRIOR TO THIS PROGRAM."
1035 PRINT "HINEM ALSO MUST HAVE BEEN SET"
1036 PRINT : PRINT
1040 PRINT : PRINT "THE FOLLOWING EXAMPLE PROGRAMS ARE READY TO RUN:
  ": PRINT
1050 PRINT " 1...HI-RES SKETCH USING GAME PADDLES"
1060 PRINT " 2...RANDOM VERTICALS & HORIZONTALS"
1070 PRINT " 3...SIMPLE 2-D WITH ZOOM"
1080 PRINT " 4...CLARK'S ART GALLERY"
1200 PRINT "99...END JOB"
1300 PRINT : PRINT : PRINT
1400 INPUT "WHICH ONE DO YOU WISH", WHICH
1410 IF WHICH>0 AND WHICH<=4 THEN GOTO 1440
1415 IF WHICH=99 THEN END
1420 PRINT "ERROR FOUND--PLEASE TRY AGAIN"
1430 GOTO 1400
1440 GOTO 1000+500*WHICH
1450 END
1500 REM ...HIGH RESOLUTION SKETCH
1510 CALL INIT
1520 GOSUB FIRST
1525 GOSUB TELL
1530 X= PDL (0)
1540 Y= PDL (1)
1550 IF Y>159 THEN Y=159
1560 GOSUB WIPE
1570 GOSUB KEY
1580 COLOUR=W
1590 GOSUB POINT
1600 CALL LINE
1610 GOTO 1530

```

```

2000 REM ...RANDOM VERTICALS AND HORIZONTALS
2010 CALL INIT
2020 GOSUB FIRST
2025 GOSUB TELL
2030 COLOUR=C( RND (3)+1)
2040 GOTO 2050+20* RND (2)
2050 X= RND (279)
2060 GOTO 2080
2070 Y= RND (159)
2080 GOSUB POINT
2090 GOSUB KEY
2100 GOSUB WIPE
2110 CALL LINE
2120 GOTO 2030
2500 REM ...SIMPLE 2-D WITH ZOOM
2510 GOSUB 2900
2520 CALL INIT
2524 PRINT : PRINT
2530 FOR W=10 TO 1 STEP -1
2540 CALL CLEAR
2550 FOR I=1 TO 56
2560 IF E(I)<20000 THEN GOTO 2580
2565 CHECK=1
2570 X=(E(I)-20000)/100
2575 GOTO 2590
2580 X=E(I)/100
2585 CHECK=0
2590 Y=E(I) MOD 100
2600 X=X*3/W+15*(W-1)
2610 Y=Y*3/W+10*(W-1)
2620 GOSUB 2800
2670 NEXT I
2680 FOR DELAY=1 TO 100
2690 DEL=DELAY+W
2700 GOSUB KEY
2710 NEXT DELAY
2720 NEXT W
2730 VTAB 23: PRINT "PRESS ANY KEY FOR MENU"
2740 GOTO 2530
2800 IF X<0 THEN X=0: IF Y<0 THEN Y=0: IF X>278 THEN X=278: IF Y>
  159 THEN Y=159
2810 GOSUB POINT
2820 IF CHECK=1 THEN GOTO 2840
2830 CALL LINE: GOTO 2850
2840 CALL POSN
2850 RETURN
2900 REM ...ENTERPRISE
2901 E(1)=20230
2902 E(2)=940
2903 E(3)=5240
2904 E(4)=5437
2905 E(5)=5730
2910 E(6)=230
2911 E(7)=1029
2912 E(8)=2228
2913 E(9)=4028
2914 E(10)=5730
2915 E(11)=4028
2916 E(12)=3826
2917 E(13)=3626
2918 E(14)=3422
2919 E(15)=2922
2920 E(16)=2726
2921 E(17)=3626
2922 E(18)=2426
2923 E(19)=2228
2924 E(20)=21940
2925 E(21)=3247
2926 E(22)=4340

```

8199 in the listing. Originally, I keyed in the two statements in Fig. 1. If I key LIST 8199,8200 then I get the combined lines as shown in the listing, but if I key LIST 8200 then I get line 8200 as shown above. In any case, the program works just fine.

I hope you enjoy the Hi-Res

program as much as I have. I've found it to be a good demo program when you're showing off your Apple II to visitors. By the way, the Random Horizontals and Verticals subprogram gives quite a different effect if the paddle button is kept depressed. ■



```

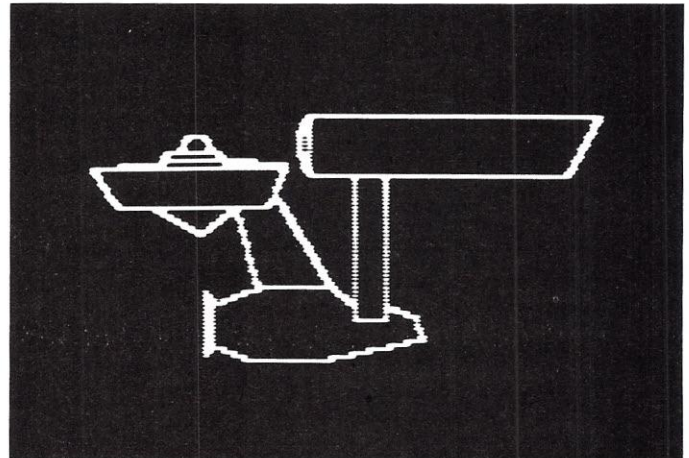
2927 E(23)=4960
2928 E(24)=7060
2929 E(25)=E(4)
2930 E(26)=7060
2931 E(27)=7765
2932 E(28)=7768
2933 E(29)=8668
2934 E(30)=8665
2935 E(31)=9568
2936 E(32)=9773
2937 E(33)=7078
2938 E(34)=4878
2939 E(35)=3674
2940 E(36)=3664
2941 E(37)=3461
2942 E(38)=3477
2943 E(39)=3674
2944 E(40)=3664
2945 E(41)=4960
2946 E(42)=27765
2947 E(43)=7732
2948 E(44)=28665
2949 E(45)=8632
2950 E(46)=6432
2951 E(47)=6229
2952 E(48)=6126
2953 E(49)=6123
2954 E(50)=6220
2955 E(51)=6417
2956 E(52)=6432
2957 E(53)=6417
2958 E(54)=15017
2959 E(55)=14032
2960 E(56)=6432
2999 RETURN
3000 REM ...CLARK'S ART GALLERY
3010 CALL INIT: POKE 768,5
3020 POKE 769,0: POKE 804,0: POKE 805,3
3026 GOSUB TELL
3030 CALL CLEAR
3040 COLOUR=C( RND (3)+1)
3050 RR= RND (3):N= RND (9)+1:N= RND (25)+3
3060 GOTO 3070+20*N RND (3)
3070 POKE 769,N
3080 GOTO 3200
3090 POKE 769,3
3100 N= RND (100)+2:N=N/10+1: GOTO 3200
3110 POKE 804, RND (5)
3120 POKE 805, RND (5)
3130 N= RND (4)
3200 FOR I=1 TO N
3210 IF RR#0 THEN COLOUR=C( RND (3)+1)
3220 X= RND (279):Y= RND (160)
3230 GOSUB POINT: CALL POSN
3235 MM= RND (N)+1
3240 FOR R=1 TO 64
3250 POKE 804,MM: POKE 807,R
3260 CALL SHAPE
3265 GOSUB KEY: GOSUB WIPE
3270 NEXT R
3280 NEXT I
3290 GOTO 3020
7998 PRINT "ERROR--REACHED 7998": END

```

```

7999 REM SUBROUTINE 'POINT' TO DEFINE X, Y, AND COLOUR AS REQUIRED B
Y MACHINE LANGUAGE PROGRAM
8000 POKE 828,COLOUR
8010 POKE 800,X MOD 255
8020 POKE 801,X/255
8030 POKE 802,Y
8040 RETURN
8100 REM ...SUBROUTINE 'FIRST' TO REMOVE INITIAL LINE
8110 COLOUR=0
8120 X= PDL (0)
8130 Y= PDL (1)
8140 GOSUB POINT
8150 CALL PLOT: CALL CLEAR
8160 RETURN
8199 REM ...'GOSUB WIPE' TO CLEAR SCREEN BY PUSHING PADDLE BUTTON.:
, RUN * IF PEEK (-16287)>127 OR PEEK (-16286)>127 THEN CALL
CLEAR
8210 POKE -16296,0
8220 RETURN
8299 REM ...'GOSUB KEY' TO RETURN TO MENU IF ANY KEY PRESSED.
8300 IF PEEK (-16384)>127 THEN GOTO 8330
8310 POKE -16368,0
8320 RETURN
8330 POKE -16368,0
8340 GOTO 1000
8350 REM ...'GOSUB TELL' FOR WIPE/KEY INSTRUCTIONS ON SCREEN
8360 CALL -936
8370 VTAB (21)
8380 PRINT "PRESS PADDLE BUTTON TO CLEAR, OR ANY KEY FOR MENU"
8390 RETURN
9200 RETURN
10300 PRINT : PRINT "MACHINE LANGUAGE PROGRAM FROM APPLE'S HIGH RESO
LUTION DEMO TAPE MUST BE LOADED PRIOR TO THIS PROGRAM."

```



Example of 2-D sketch of "Enterprise."

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Super Elf and expansion board. All options plus super monitor and Tiny BASIC on ROM. Complete documentation, all for \$190. G. Patrick, Apt. 2-9E, 531 Hahaine, Honolulu HI 96825.

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For Sale: North Star floating-point board & manual, \$250. Sol & 32K memory, CRT, cassette recorder, BASIC5, ext. cassette BASIC, ASL-8, FOCAL & manuals, \$1600. CUTS cassette interface rev. B & manual, \$80. Two Tarbell cassette interfaces rev. D & manual, \$80 each. D. G. Kissinger, School of Health, Loma Linda Univ., Loma Linda CA 92350. (714) 796-7272.

SWTP 6800 4K unit assembled and tested, no peripherals, complete with manuals—asking \$400. Cdn funds. Ed Vander Ryd, P.O. Box 4166, Stn. D, Hamilton, Ontario, Canada L8V 4L5.

Need: IC, type #SW-10667 pt #14027 used in 1622 Diablo keyboard, micro switch #75SD12-4. Also KB timing diagrams. Jim Jamison, 2304 Tucker, Rte. 6, N.E., No. Ft. Myers FL 33903.

For Sale: Commodore PET 2023 friction feed printer. New/never used. Cost \$849. Will sell for \$700. G. H. Ashley, 25 Whitney Tavern Rd., Weston MA 02193, (617) 894-4334.

For Sale: New Apple II, disks, Applesoft ROM card, printer, D.C. Hayes modem, CRT monitor, clock calendar card, graphics input tablet, Applewriter word processor program. Sell all or part. Call Don at (714) 776-6384 or send for list of items with prices. D. Anderl, Box 20EA, Fullerton CA 92633.

For Sale: KIM-1 single board computer. Original doc. extra on expanding, etc. Must sell, \$150. Wanted: 4115s from upgraded PETs 8/\$20. John Lemkelde, 5980 Bull Rd., Dover PA 17315, (717) 292-4933.

Wanted: Utility billing package for TRS-80 Model II running under CP/M or TRSDOS. Send information and price to: Edwin Phillips, 928 Davis, New Madrid MO 63869.

For Sale: KIM-1 includes 1K RAM, 2K ROM, power supply, 3 manuals, plus *Programming a Micro: 6502*. Asking \$125/best offer. Call Ed (617) 544-2207 in PM.

For Sale: Soroc IQ 120 terminal in original carton, \$595. Don Pittman, 1816 Cleary Ave., Metairie LA 70001. (504) 837-3267.

Wanted: Ohio Scientific C-3B and/or 74 meg hard disk. And/or OSI C30EM. Bill Brown, San Juan Bocs, 201 12 Street, Durango CO 81301.

For Sale: Digital Equipment PDP8/L, \$300. C. L. Jones, 2338 Raunsdale Rd., Kettering OH 45440. (513) 449-6796.

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AIM-65 for sale w/4K RAM, power supply (5 V @ 8 A, 24 V @ 2 A, plus!) Current loop & audio cables. Mint cond. \$400. Call (617) 997-2811, ext. 783, ask for Paul Smola.

# CALENDAR

## Waltham MA

Anyone interested in learning more about the Exatron Stringy Floppy is invited to the first East Coast ESFOA Workshop, Saturday, May 31, at Micro Communications, 80 Bacon St., Waltham MA. Units available for hands-on experience; refreshments available. Workshop will run from 10 to 6. Phone (617) 899-8111 for more details or directions.

## Champaign IL

An update review of existing technology and recent advances will be presented at the Ninth Annual Symposium on Incremental Motion Control Systems and Devices, June 2-5, 1980, Ramada Inn, Champaign, Illinois. For further information, contact Professor B. C. Kuo, IMCSS, PO Box 2772, Station A, Champaign IL 61820, (217) 333-4341.

## Blacksburg VA

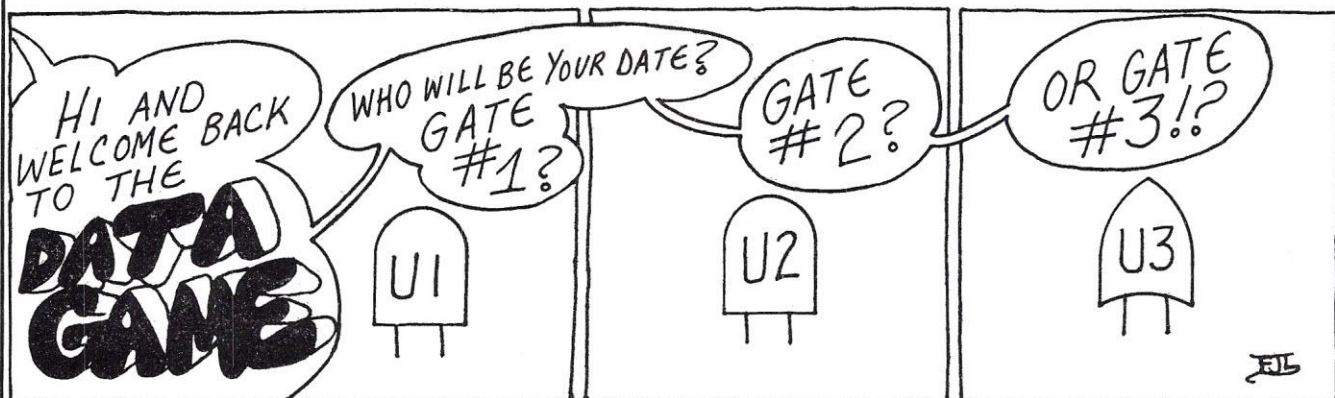
Workshop: TRS-80 Interfacing and Programming for Instrumentation and Control. June 23-27, 1980. This is a hands-on workshop with the participants working with and designing interfaces for the TRS-80. For more information, contact Dr. Linda Leffel, CEC, Virginia Tech., Blacksburg VA 24061, (703) 961-5241.

## Philadelphia PA

The fifth Produx 2000 will be held May 21-23, 1980, at the Philadelphia Civic Center from 11 AM-6 PM. Contact Produx 2000, Inc., (215) 457-2300 to reserve space.

## Guelph Ontario

Central Ontario Amateur Radio Flea Market and Computer Fest will be held at the Centennial Arena, College Ave. West, Guelph Ontario, Saturday, June 7, 1980, 8 AM to 4 PM. Admission only \$1 (12 years and under—free). For further information, please contact Rocco Furfaro VE3HGZ, (519) 824-1157.





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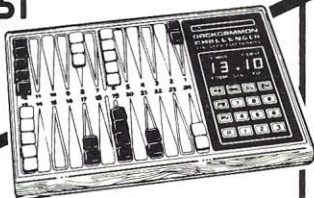
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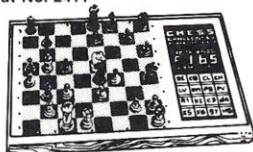
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● **TRS-80 DISK AND OTHER MYSTERIES** — BK1181 — by Harvard C. Pennington. This is the definitive work on the TRS-80 disk system. It is full of detailed "How to" information with examples, samples and in-depth explanations suitable for beginners and professionals alike. The recovery of one lost file is worth the price alone. \$22.50.\*

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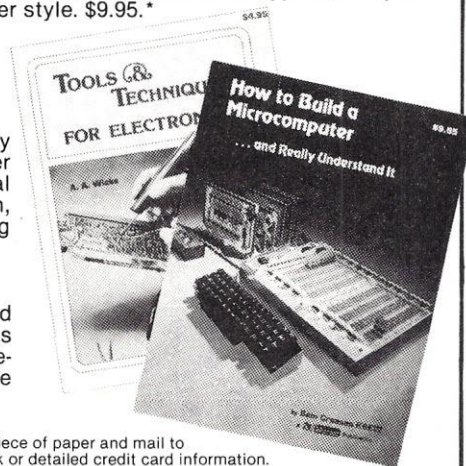
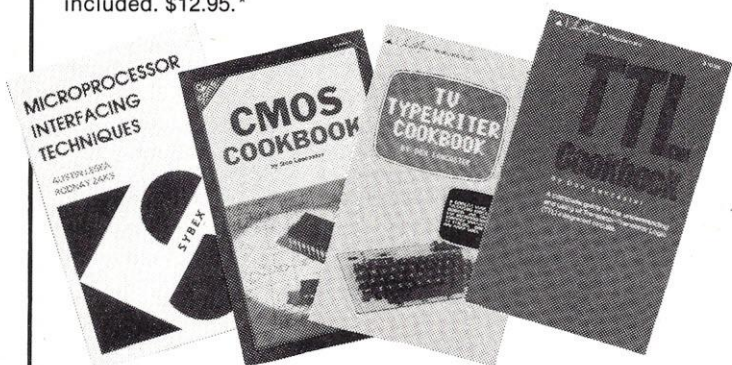
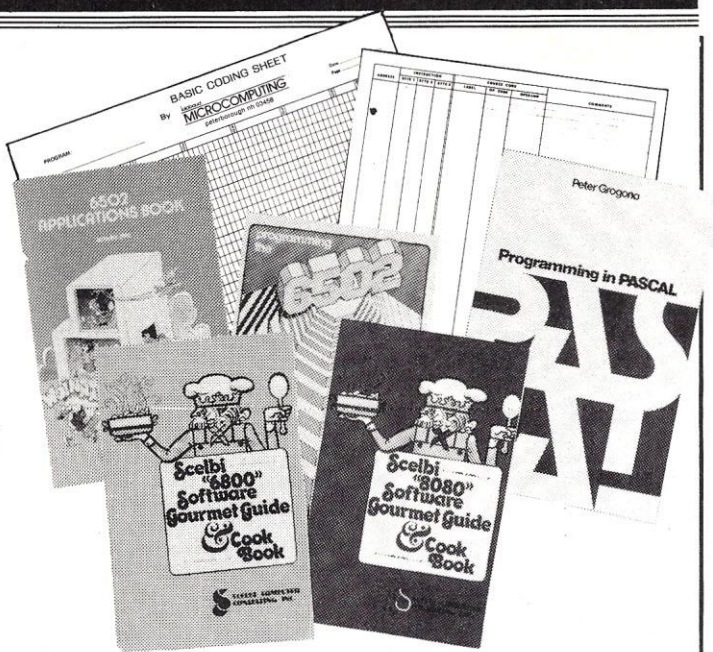
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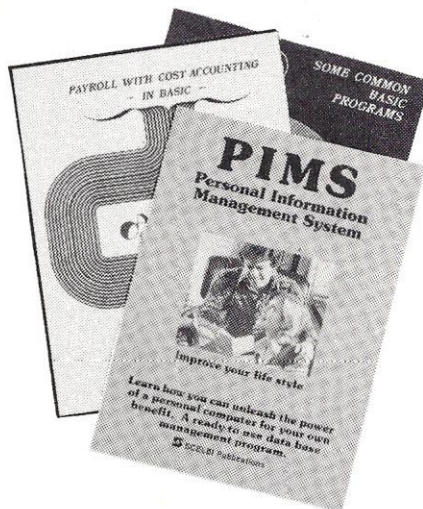
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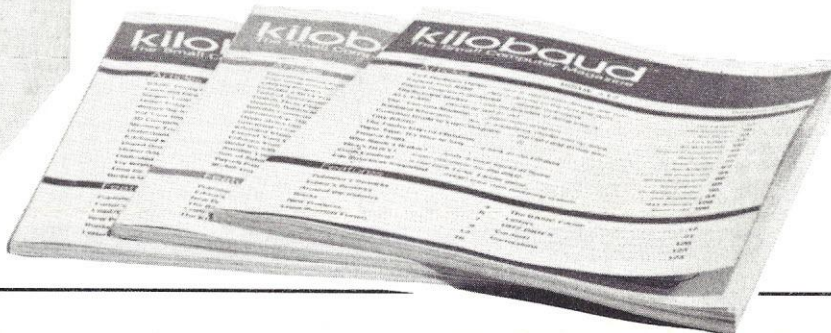
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Easily adaptable on most 1802 systems. Requires 12K RAM minimum for Basic and user

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Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The Super Elf includes a ROM monitor for program loading, editing and execution with SINGLE STEP for program debugging which is not included in others at the same price. With SINGLE STEP you can see the microprocessor chip operating with the unique Quest address and data bus displays before, during and after executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 video graphics chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a speaker system included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

## Super Expansion Board with Cassette Interface \$89.95

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**A IK Super ROM Monitor \$19.95** is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with

A 24 key HEX keyboard includes 16 HEX keys plus load, reset, run, wait, input, memory protect, monitor select and single step. Large, on board displays provide output and optional high and low address. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for all IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. Including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R&D.

Remember, other computers only offer Super Elf features at additional cost or not at all. Compare before you buy. Super Elf Kit \$106.95, High address option \$8.95, Low address option \$9.95. Custom Cabinet with drilled and labelled plexiglass front panel \$24.95. Expansion Cabinet with room for 4 S-100 boards \$41.00. NiCad Battery Memory Saver Kit \$6.95. All kits and options also completely assembled and tested. Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for \$12.00 per year. Issues 1-12 bound \$16.50.

Tiny Basic Cassette \$10.00, on ROM \$38.00, original Elf kit board \$14.95. 1802 software; Moew's Video Graphics \$3.50. Games and Music \$3.00, Chip 8 Interpreter \$5.50.

subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the Super Expansion Board and Super Monitor the monitor is up and running at the push of a button.

Other on board options include Parallel Input and Output Ports with full handshake. They allow easy connection of an ASCII keyboard to the input port. RS 232 and 20 ma Current Loop for teletype or other device are on board and if you need more memory there are two S-100 slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. Parallel I/O Ports \$9.85, RS 232 \$4.50, TTY 20 ma I/F \$1.95, S-100 \$4.50. A 50 pin connector set with ribbon cable is available at \$15.25 for easy connection between the Super Elf and the Super Expansion Board.

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| 7433N  | LM323K-15 | 1.50 | CD4049 | 2.80 | MM5339 | 3.90 |
| 7434N  | LM323K-15 | 1.50 | CD4050 | 2.80 | MM5340 | 3.90 |
| 7435N  | LM323K-15 | 1.50 | CD4051 | 2.80 | MM5341 | 3.90 |
| 7436N  | LM323K-15 | 1.50 | CD4052 | 2.80 | MM5342 | 3.90 |
| 7437N  | LM323K-15 | 1.50 | CD4053 | 2.80 | MM5343 | 3.90 |
| 7438N  | LM323K-15 | 1.50 | CD4054 | 2.80 | MM5344 | 3.90 |
| 7439N  | LM323K-15 | 1.50 | CD4055 | 2.80 | MM5345 | 3.90 |
| 7440N  | LM323K-15 | 1.50 | CD4056 | 2.80 | MM5346 | 3.90 |
| 7441N  | LM323K-15 | 1.50 | CD4057 | 2.80 | MM5347 | 3.90 |
| 7442N  | LM323K-15 | 1.50 | CD4058 | 2.80 | MM5348 | 3.90 |
| 7443N  | LM323K-15 | 1.50 | CD4059 | 2.80 | MM5349 | 3.90 |
| 7444N  | LM323K-15 | 1.50 | CD4060 | 2.80 | MM5350 | 3.90 |
| 7445N  | LM323K-15 | 1.50 | CD4061 | 2.80 | MM5351 | 3.90 |
| 7446N  | LM323K-15 | 1.50 | CD4062 | 2.80 | MM5352 | 3.90 |
| 7447N  | LM323K-15 | 1.50 | CD4063 | 2.80 | MM5353 | 3.90 |
| 7448N  | LM323K-15 | 1.50 | CD4064 | 2.80 | MM5354 | 3.90 |
| 7449N  | LM323K-15 | 1.50 | CD4065 | 2.80 | MM5355 | 3.90 |
| 7450N  | LM323K-15 | 1.50 | CD4066 | 2.80 | MM5356 | 3.90 |
| 7451N  | LM323K-15 | 1.50 | CD4067 | 2.80 | MM5357 | 3.90 |
| 7452N  | LM323K-15 | 1.50 | CD4068 | 2.80 | MM5358 | 3.90 |
| 7453N  | LM323K-15 | 1.50 | CD4069 | 2.80 | MM5359 | 3.90 |
| 7454N  | LM323K-15 | 1.50 | CD4070 | 2.80 | MM5360 | 3.90 |
| 7455N  | LM323K-15 | 1.50 | CD4071 | 2.80 | MM5361 | 3.90 |
| 7456N  | LM323K-15 | 1.50 | CD4072 | 2.80 | MM5362 | 3.90 |
| 7457N  | LM323K-15 | 1.50 | CD4073 | 2.80 | MM5363 | 3.90 |
| 7458N  | LM323K-15 | 1.50 | CD4074 | 2.80 | MM5364 | 3.90 |
| 7459N  | LM323K-15 | 1.50 | CD4075 | 2.80 | MM5365 | 3.90 |
| 7460N  | LM323K-15 | 1.50 | CD4076 | 2.80 | MM5366 | 3.90 |
| 7461N  | LM323K-15 | 1.50 | CD4077 | 2.80 | MM5367 | 3.90 |
| 7462N  | LM323K-15 | 1.50 | CD4078 | 2.80 | MM5368 | 3.90 |
| 7463N  | LM323K-15 | 1.50 | CD4079 | 2.80 | MM5369 | 3.90 |
| 7464N  | LM323K-15 | 1.50 | CD4080 | 2.80 | MM5370 | 3.90 |
| 7465N  | LM323K-15 | 1.50 | CD4081 | 2.80 | MM5371 | 3.90 |
| 7466N  | LM323K-15 | 1.50 | CD4082 | 2.80 | MM5372 | 3.90 |
| 7467N  | LM323K-15 | 1.50 | CD4083 | 2.80 | MM5373 | 3.90 |
| 7468N  | LM323K-15 | 1.50 | CD4084 | 2.80 | MM5374 | 3.90 |
| 7469N  | LM323K-15 | 1.50 | CD4085 | 2.80 | MM5375 | 3.90 |
| 7470N  | LM323K-15 | 1.50 | CD4086 | 2.80 | MM5376 | 3.90 |
| 7471N  | LM323K-15 | 1.50 | CD4087 | 2.80 | MM5377 | 3.90 |
| 7472N  | LM323K-15 | 1.50 | CD4088 | 2.80 | MM5378 | 3.90 |
| 7473N  | LM323K-15 | 1.50 | CD4089 | 2.80 | MM5379 | 3.90 |
| 7474N  | LM323K-15 | 1.50 | CD4090 | 2.80 | MM5380 | 3.90 |
| 7475N  | LM323K-15 | 1.50 | CD4091 | 2.80 | MM5381 | 3.90 |
| 7476N  | LM323K-15 | 1.50 | CD4092 | 2.80 | MM5382 | 3.90 |
| 7477N  | LM323K-15 | 1.50 | CD4093 | 2.80 | MM5383 | 3.90 |
| 7478N  | LM323K-15 | 1.50 | CD4094 | 2.80 | MM5384 | 3.90 |
| 7479N  | LM323K-15 | 1.50 | CD4095 | 2.80 | MM5385 | 3.90 |
| 7480N  | LM323K-15 | 1.50 | CD4096 | 2.80 | MM5386 | 3.90 |
| 7481N  | LM323K-15 | 1.50 | CD4097 | 2.80 | MM5387 | 3.90 |
| 7482N  | LM323K-15 | 1.50 | CD4098 | 2.80 | MM5388 | 3.90 |
| 7483N  | LM323K-15 | 1.50 | CD4099 | 2.80 | MM5389 | 3.90 |
| 7484N  | LM323K-15 | 1.50 | CD4100 | 2.80 | MM5390 | 3.90 |
| 7485N  | LM323K-15 | 1.50 | CD4101 | 2.80 | MM5391 | 3.90 |
| 7486N  | LM323K-15 | 1.50 | CD4102 | 2.80 | MM5392 | 3.90 |
| 7487N  | LM323K-15 | 1.50 | CD4103 | 2.80 | MM5393 | 3.90 |
| 7488N  | LM323K-15 | 1.50 | CD4104 | 2.80 | MM5394 | 3.90 |
| 7489N  | LM323K-15 | 1.50 | CD4105 | 2.80 | MM5395 | 3.90 |
| 7490N  | LM323K-15 | 1.50 | CD4106 | 2.80 | MM5396 | 3.90 |
| 7491N  | LM323K-15 | 1.50 | CD4107 | 2.80 | MM5397 | 3.90 |
| 7492N  | LM323K-15 | 1.50 | CD4108 | 2.80 | MM5398 | 3.90 |
| 7493N  | LM323K-15 | 1.50 | CD4109 | 2.80 | MM5399 | 3.90 |
| 7494N  | LM323K-15 | 1.50 | CD4110 | 2.80 | MM5400 | 3.90 |
| 7495N  | LM323K-15 | 1.50 | CD4111 | 2.80 | MM5401 | 3.90 |
| 7496N  | LM323K-15 | 1.50 | CD4112 | 2.80 | MM5402 | 3.90 |
| 7497N  | LM323K-15 | 1.50 | CD4113 | 2.80 | MM5403 | 3.90 |
| 7498N  | LM323K-15 | 1.50 | CD4114 | 2.80 | MM5404 | 3.90 |
| 7499N  | LM323K-15 | 1.50 | CD4115 | 2.80 | MM5405 | 3.90 |
| 7500N  | LM323K-15 | 1.50 | CD4116 | 2.80 | MM5406 | 3.90 |

|            |      |                  |       |          |      |                      |
|------------|------|------------------|-------|----------|------|----------------------|
| 74LS10N    | 7407 | 745494CN         | 89    | 74AC03A  | 6.00 | 8278                 |
| 74LS10N    | 7407 |                  |       | 74AC04A  | 6.00 | 8278                 |
| 74LS13N    | 7410 | A to D CONVERTER |       | 74AC15A  | 1.95 | 8251                 |
| 74LS11N    | 45   | 80398            | 4.50  | 74AC22   | 5.50 | 8255                 |
| 74LS12N    | 85   | 87002C           | 13.95 | 74AC23A  | 5.50 | 8255                 |
| 74LS12N    | 89   | 87017B           | 22.00 | 74AC25   | 6.05 | 8257                 |
| 74LS16N    | 135  | 85150            | 13.95 | 74AC26   | 6.05 | 8257                 |
| 74LS16N    | 135  | 85150            | 13.95 | 74AC27   | 6.05 | 8257                 |
| 74LS155N   | 85   | 8400CJ/VF        | 7.40  | 74AC27   | 6.05 | 1802C <sup>1</sup>   |
| 74LS155N   | 85   | 8400CJ/VF        | 7.40  | 74AC28   | 6.05 | 1802C <sup>1</sup>   |
| 74LS162N   | 115  | ICM107           | 14.25 | 8095     | 6.05 | 1801P <sup>1</sup>   |
| 74LS163N   | 115  | CL70             |       | 8096     | 6.05 | CP1802B <sup>1</sup> |
| 74LS164N   | 115  | CL70             |       | 8097     | 6.05 | CP1802B <sup>1</sup> |
| 74LS190N   | 195  | CD3401           | 4.00  | 8098     | 6.05 | CP1801B <sup>1</sup> |
| 74LS221N   | 195  | CD4001A          | 16    | 8099     | 6.05 | CP1801B <sup>1</sup> |
| 74LS239N   | 85   | 82002C           | 11.00 | 8100     | 6.05 | UART/FIF             |
| 74LS367N   | 135  | CD4002           | 28    | 8101     | 4.50 | AY5-1013             |
|            |      | CD4002           | 28    | 8102     | 4.50 | 3341                 |
|            |      | CD4007           | 28    | 8123     | 3.00 |                      |
| LINEAR     |      | CD4007           | 28    | 8123     | 3.00 | PROM                 |
| CA304N     | 90   | CD4008           | 28    | 8124     | 3.00 | 1002A                |
| CA304N     | 110  | CD4008           | 28    | 8125     | 3.00 | 1002A                |
| CA3081     | 180  | CD4010           | 45    | 8126     | 1.68 | 2708                 |
| CA3082     | 180  | CD4010           | 45    | 8127     | 1.68 | 2708                 |
| CA3082     | 195  | CD4011           | 28    | 8128     | 1.68 | 2716T <sup>1</sup>   |
| CA3082     | 195  | CD4011           | 28    | 8129     | 1.68 | 2716T <sup>1</sup>   |
| CA3010A/AR | 35   | CA0413           | 39    | 8196     | 1.69 | 8271E LINE           |
| LM305H     | 87   | CD4014           | 1.00  |          |      | 2732                 |
| LM305H     | 87   | CD4014           | 1.00  |          |      | 2732                 |
| LM308N     | 89   | CD4016           | 45    |          |      | 8741A                |
| LM308N     | 89   | CD4016           | 45    |          |      | 8741A                |
| LM311N     | 90   | CD4018           | 1.95  |          |      | 957A                 |
| LM311H     | 90   | CD4018           | 1.95  |          |      | 957A                 |
| LM317H     | 3.75 | CD4019           | 45    | 2102-1   | 1.35 | 6741A                |
| LM317H     | 3.75 | CD4019           | 45    | 2102-1   | 1.35 | 6741A                |
| LM320K-5   | 5.50 |                  |       | 2102L-4  | 1.25 | 6755A                |
|            |      |                  |       | 2102L-2L | 1.25 | 6755A                |
|            |      |                  |       | 2102L-1  | 1.25 | 6755A                |



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## THE COMPLETE PC BOARD HOUSE EVERYTHING FOR THE S-100 BUSS

### INTRODUCTORY SPECIAL IOB-1 SERIAL/PARALLEL INTERFACE BOARD

- \* TWO PARALLEL DATA PORTS PROGRAMMABLE USING AN 8255 WITH SEPARATE HANDSHAKING.
  - \* ONE SERIAL PORT USING AN 8251 WITH PROVISIONS FOR PARITY, STOP BIT AND CHARACTER LENGTH. BAUD RATES 110 TO 9600 BAUD. OUTPUTS RS232, TTL AND CURRENT LOOP.
  - \* KANSAS CITY STANDARD CASSETTE INTERFACE, 300 BAUD FOR USE WITH THE SERIAL INTERFACE.
  - \* STATUS MAY BE POLLING SOFTWARE OR VECTURED INTERRUPTS.
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KIT TO BE ANNOUNCED LATER.

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Z-80 CPU BOARD WITH RAM, ROM AND PROGRAMMABLE VECTOR INTERRUPTS.

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#### CALIFORNIA COMPUTER SYSTEMS

**16K RAM BOARD.** Fully buffered addressable in 4K blocks. IEEE standard for bank addressing 2114's. PCBD .....\$ 26.95 Kit 450 NSEC .....\$249.95

**PT-1 PROTO BOARD.** Over 2,600 holes 4" regulators. All S-100 buss functions labeled, gold fingers. PCBD .....\$25.95

**PT-2 PROTO BOARD.** Similar to PT-1 except set-up to handle solder tail sockets. PCBD .....\$25.95

**CCS MAIN FRAME.** Kit (S-100) .....\$349.95

**APPLE EXTENDER.** Kit .....\$22.95

**APPLE IEEE INSTRUMENTATION INTERFACE** KIT 7490. Kit .....\$275.00

**ARITHMETIC PROCESSOR FOR APPLE 7811A.** Kit .....\$350.00

**APPLE ASYNCHRONOUS SERIAL INTERFACE** 7710A. Kit .....\$89.95

**APPLE SYNCHRONOUS SERIAL INTERFACE** 7712A. Kit .....\$89.95

ALL OTHER CCS PRODUCTS AVAILABLE



**PB-1** 2708 & 2716 Programming Board with provisions for 4K or 8K EPROM. No external supplies require textool sockets. Kit .....\$129.95

**CB-1A** 8080 Processor Board. 2K of PROM 256 BYTE RAM power on/rest Vector Jump Parallel port with status. Kit .....\$129.95 PCBD .....\$27.95

**VB-3** 80 x 55 VIDEO BOARD. Graphic included ..... TBD

**IO-4** Two serial I/O ports with full handshaking 20/60 ma current loop: Two parallel I/O ports. Kit .....\$130.00 PCBD .....\$26.95

**VB-1B** 64 x 16 video board, upper lower case Greek composite and parallel video with software, S-100. Kit .....\$125.00 PCBD .....\$26.95

**CB-2** Z80 CPU BOARD. Kit .....\$185.95

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**FDC-1** FLOPPY CONTROLLER BOARD will drive shugart, pertek, remic 5" & 8" drives up to 8 drives, on board PROM with power boot up, will operate with CPM™ (not included). PCBD .....\$42.95

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**MEM-1A** 8K x 8 fully buffered, S-100, uses 2102 type rams. PCBD .....\$25.95

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**CPU-1** 8080A Processor board S-100 with 8 level vector interrupt. PCBD .....\$26.95

**RTC-1** Realtime clock board. Two independent interrupts. Software programmable. PCBD .....\$23.95

**EPM-1** 1702A 4K Eprom card. PCBD .....\$25.95

**EPM-2** 2708/2716 16K/32K EPROM CARD. PCBD .....\$25.95

**QM-9** MOTHER BOARD. Short Version of QM-12. 9 Slots. PCBD .....\$30.95

**MEM-2** 16K x 8 Fully Buffered 2114 Board. PCBD .....\$26.95

**PTB-1** POWER SUPPLY AND TERMINATOR BOARD. PCBD .....\$25.95

**IOB-1** SERIAL AND PARALLEL INTERFACE. 2 parallel, one serial and cassette. PCBD .....\$26.95

2708 .....\$9.49 2114 (200 NS) low pwr. 2114 (450 NS) low pwr. 5.99 .....\$6.99

# MIKOS

NOTE:  
NEW ADDRESS AND PHONE (415) 726-7593  
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#### MAY SPECIAL SALE ON PREPAID ORDERS

(Charge cards not included on this offer)

**IO-4 LAYOUT REJECTS.** One simple change. PCBD .....\$20.00

**8K x 8 RAM.** Fully buffered. 450 NSEC assembled and tested. ....\$99.99

#### MIKOS PARTS ASSORTMENT

##### WITH WAMECO AND CYBERCOM PCBDs

**MEM-2** with MIKOS #7 16K ram .....\$249.95

with L2114 450 NSEC

**MEM-2** with MIKOS #13 16K ram .....\$279.95

with L2114 250 NSEC

**MEM-1** with MIKOS #1 450 NSEC 8K RAM .....\$119.95

**CPU-1** with MIKOS #2 8080A CPU .....\$ 94.95

**QM-12** with MIKOS #4 13 slot mother board .....\$ 89.95

**RTC-1** with MIKOS #5 real time clock .....\$ 54.95

**EMP-1** with MIKOS #10 4K 1702 less EPROMS .....\$ 49.95

**EPM-2** with MIKOS #11 16-32K EPROMS less EPROMS .....\$ 59.95

**QM-9** with MIKOS #12 9 slot mother board .....\$ 79.95

**FPB-1** with MIKOS #14 all parts for front panel .....\$134.95

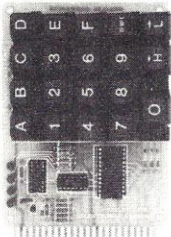
MIKOS PARTS ASSORTMENTS ARE ALL FACTORY MARKED PARTS. KITS INCLUDE ALL PARTS LISTED AS REQUIRED FOR THE COMPLETE KIT LESS PARTS LISTED. ALL SOCKETS INCLUDED.

VISA or MASTERCHARGE. Send account number, interbank number, expiration date and sign your order. Approx. postage will be added. Check or money order will be sent post paid in U.S. If you are not a regular customer, please use charge, cashier's check or postal money order. Otherwise there will be a two-week delay for checks to clear. Calif. residents add 6% tax. Money back 30-day guarantee. We cannot accept returned IC's that have been soldered to. Prices subject to change without notice. \$10 minimum order. \$1.50 service charge on orders less than \$10.00.

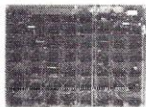


### HEX ENCODED KEYBOARD

Four onboard LEDs indicate the HEX code generated for each key depression. The board requires a single +5 volt supply. Board only \$15.00 Part No. HEX-3, with parts \$49.95 Part No. HEX-3A, 44 pin edge connector \$4.00 Part No. 44P.



### T.V. TYPEWRITER



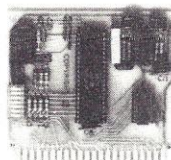
- Stand alone TVT
- 32 char./line, 16 lines, modifications for 64 char./line included
- Parallel ASCII (TTL) input
- Video output
- 1K on board memory
- Output for computer controlled cursor
- Auto scroll
- Non-destructive cursor
- Cursor inputs: up, down, left, right, home, EOL, EOS
- Scroll up, down
- Requires +5 volts at 1.5 amps, and -12 volts at 30 mA
- All 7400, TTL chips
- Char. gen. 2513
- Upper case only
- Board only \$39.00 Part No. 106, with parts \$145.00 Part No. 106A

### 44 BUS MOTHER BOARD



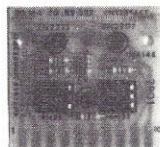
Has provisions for ten 44 pin (.156) connectors, spaced 3/4 of an inch apart. Pin 20 is connected to X, and 22 is connected to Z for power and ground. All the other pins are connected in parallel. This board also has provisions for bypass capacitors. Board cost \$15.00 Part No. 102. Connectors \$3.00 each Part No. 44WP.

### UART & BAUD RATE GENERATOR



- Converts serial to parallel and parallel to serial
- Low cost on board baud rate generator
- Baud rates: 110, 150, 300, 600, 1200, and 2400
- Low power drain +5 volts and -12 volts required
- TTL compatible
- All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity
- All connections go to a 44 pin gold plated edge connector
- Board only \$12.00 Part No. 101, with parts \$35.00 Part No. 101A, 44 pin edge connector \$4.00 Part No. 44P

### RS-232/20mA INTERFACE



This board has two passive, opto-isolated circuits. One converts RS-232 to 20mA, the other converts 20mA to RS-232. All connections go to a 10 pin edge connector. Requires +12 and -12 volts. Board only \$9.95, part no. 7901, with parts \$14.95 Part No. 7901A.

### ASCII TO CORRESPONDENCE CODE CONVERTER

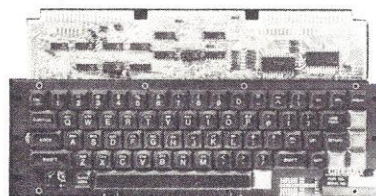
This bidirectional board is a direct replacement for the board inside the Trendata 1000 terminal. The on board connector provides RS-232 serial in and out. Sold only as an assembled and tested unit for \$249.95. Part No. TA 1000C

### ASCII KEYBOARD

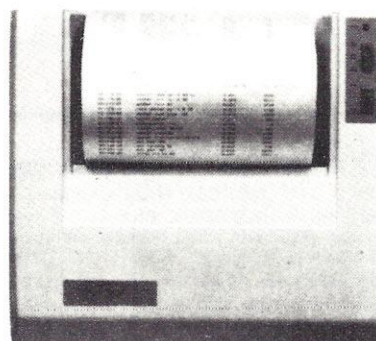
53 Keys popular ASR-33 format • Rugged G-10 P.C. Board • Tri-mode MOS encoding • Two-Key Rollover • MOS/DTL/TTL Compatible • Upper Case lockout • Data and Strobe inversion option • Three User Definable Keys • Low contact bounce • Selectable Parity • Custom Keycaps • George Risk Model 753. Requires +5, -12 volts. \$59.95 Kit.

### ASCII KEYBOARD

TTL & DTL compatible • Full 67 key array • Full 128 character ASCII output • Positive logic with outputs resting low • Data Strobe • Five user-definable spare keys • Standard 22 pin dual card edge connector • Requires +5VDC, 325 mA. Assembled & Tested. Cherry Pro Part No. P70-05AB. \$119.95.



### COMPRINT PRINTER



**Printing Characteristics:** 225 characters/second (170 lines/minute) throughput • 9 horizontal x 12 vertical matrix • 96 ASCII character set with upper and true lower case • 80 characters/line • 5.8 lines/inch

**Buffer Memory:** standard 256 bytes; optional: 2,048 bytes (buffer memory option designated as Model 912-2K), add \$149.95.

**Paper Requirements:** electrosensitive type (aluminum coated) • 8-1/2 inch width • 3.7 inch max. (300 ft.) roll diameter.

**Model 912-S Interfacing:** serial interface RS232 and 20 mA current loop • BAUD rates 110, 150, 300, 600, 1200, 2400 and 4800 are strap selectable.

**Model 912-P Interfacing:** parallel interface, IEEE-488 and 8 bit parallel (strobe/acknowledge). Model 912-S, Part No. CPIA, 32118, \$579.95. Model 912-P, Part No. CPIA, 32117, \$559.95.

### T.V. INTERFACE



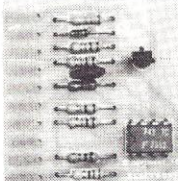
- Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple
- Power required is 12 volts AC C.T., or +5 volts DC
- Board only \$7.60 part No. 107, with parts \$13.50 Part No. 107A

### SOROC IQ 120



Upper/lower case display • Numeric keypad & cursor keys • Protected fields, 1/2 intensity display • RS 232 interface & aux. port. IQ120—\$799.95 • IQ140 Detachable keyboard—\$1199.95

### RS-32/TTL INTERFACE



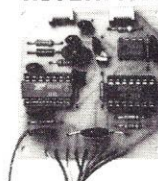
- Converts TTL to RS-232, and converts RS-232 to TTL
- Two separate circuits
- Requires -12 and +12 volts
- All connections go to a 10 pin edge connector, kit \$9.95 Part No. 232A 10P, edge connector \$3.00 part No. 10P.

### DC POWER SUPPLY

- Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp.
- Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps.
- Board only \$12.50 Part No. 6085, with parts excluding transformers \$42.50 Part No. 6085A

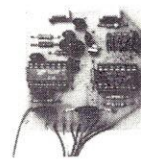


### TAPE INTERFACE



- Converts a low cost tape recorder to a digital recorder
- Works up to 1200 baud
- Digital in and out are TTL serial
- Output of board connects to mic. in of recorder
- Earphone of recorder connects to input on board
- No coils
- Requires +5 volts, low power drain
- Board only \$7.60 Part No. 111, with parts \$29.95 Part No. 111A

### MODEM



- Type 103
- Full or half duplex
- Works up to 300 baud
- Originate or Answer
- Serial TTL input and output
- connect 8 Ω speaker and crystal mic. directly to board
- Requires +5 volts
- Board only \$7.60 Part No. 109, with parts \$29.95 Part No. 109A.

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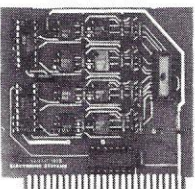
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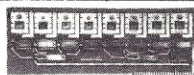
There are 8 inputs that can be driven from TTL logic or any 5 volt source. The circuit board can be plugged into any of the 8 sockets of your Apple II. It has a 16 pin socket for standard dip ribbon cable connection. Board only \$15.00, Part No. 120, with parts \$69.95, Part No. 120A.

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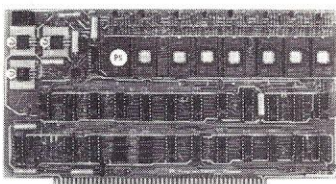
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## 8K EPROM PICEON



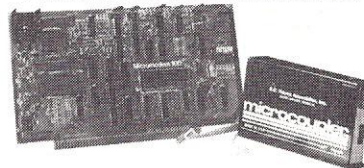
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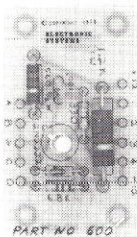


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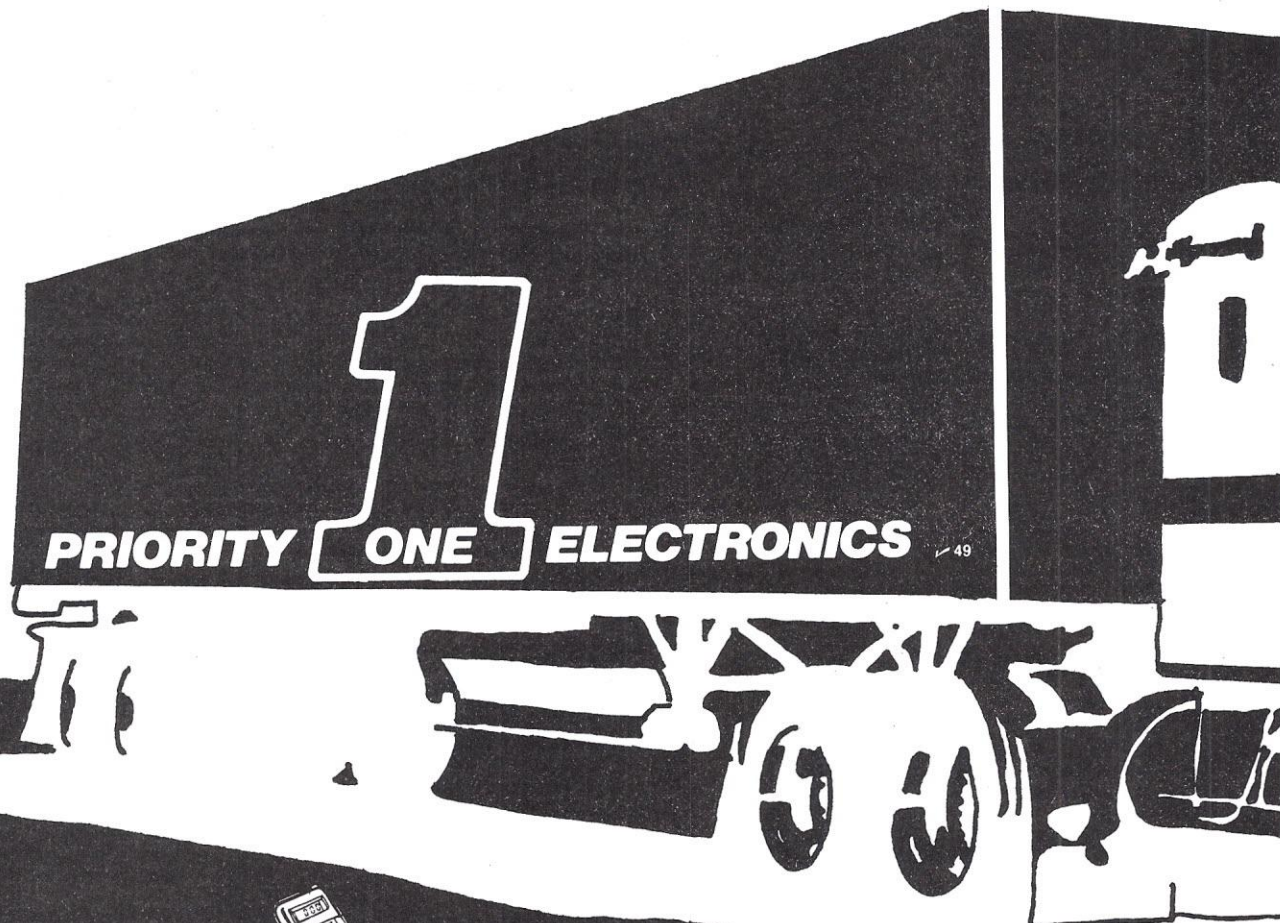
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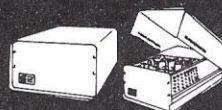
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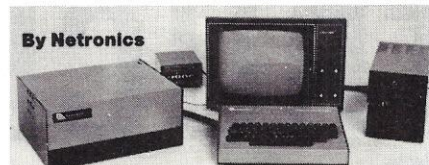
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System Monitor (Hex Version): Tape load with labeling...tape dump with labeling...examine/change contents of memory...insert data...warm start...examine and change all

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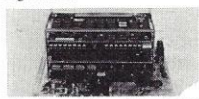
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Hex Keypad/Display.

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Explorer/85 with Level "C" card cage.

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When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

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! " # \$ % & ' ( ) \* + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ?  
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BAUDOT Character Set: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z . ? \* ' \$ % # ( ) , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ?

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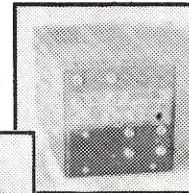
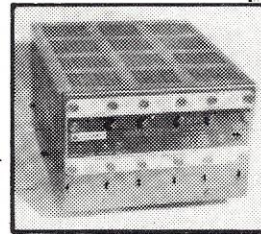
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| SN7444N  | 79  | SN74174N | 89  |
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| SN7447N  | 59  | SN74177N | 85  |
| SN7448N  | 79  | SN74179N | 180 |
| SN7450N  | 23  | SN74180N | 75  |
| SN7451N  | 23  | SN74181N | 175 |
| SN7453N  | 23  | SN74182N | 75  |
| SN7454N  | 23  | SN74184N | 195 |
| SN7455N  | 29  | SN74185N | 195 |
| SN7456N  | 29  | SN74186N | 195 |
| SN7457N  | 29  | SN74188N | 390 |
| SN7472N  | 34  | SN74190N | 115 |
| SN7473N  | 36  | SN74191N | 115 |
| SN7474N  | 36  | SN74192N | 85  |
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| SN7483N  | 55  | SN74199N | 139 |
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| SN7490N  | 39  | SN74279N | 89  |
| SN7491N  | 65  | SN74283N | 215 |
| SN7492N  | 62  | SN74284N | 390 |
| SN7493N  | 49  | SN74285N | 390 |
| SN7494N  | 72  | SN74290N | 125 |
| SN7495N  | 65  | SN74298N | 95  |
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| 74LS138N | 69  | 74LS375N | 69  |
| 74LS139N | 69  | 74LS377N | 195 |
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| 74LS146N | 149 | 74LS386N | 195 |
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| LM305H     | 98   | LM1850N    | 95  |
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| LM312H     | 175  | CA3018T    | 199 |
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| LM318CN/H  | 149  | CA3023T    | 299 |
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| LM320H-XX  | 125  | LM3053N    | 149 |
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| LM324H     | 125  | CA3060N    | 325 |
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| LM340T-XX  | 125  | CA3080N    | 129 |
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|---------------------------------|---------|
| RC3 115V AC Adapter             | \$7.50  |
| CC-3000 Precision Voltage Probe | \$7.50  |
| VP-10 X10 DVM Probe Adapter     | \$14.95 |
| Protector 10 Kv                 | \$14.95 |
| VP-40 40 Kv DVM Probe Adapter   | \$35.00 |
| CS-10 10 Amp Current Shunt      | \$14.95 |

## TEXAS INSTRUMENTS

INCORPORATED

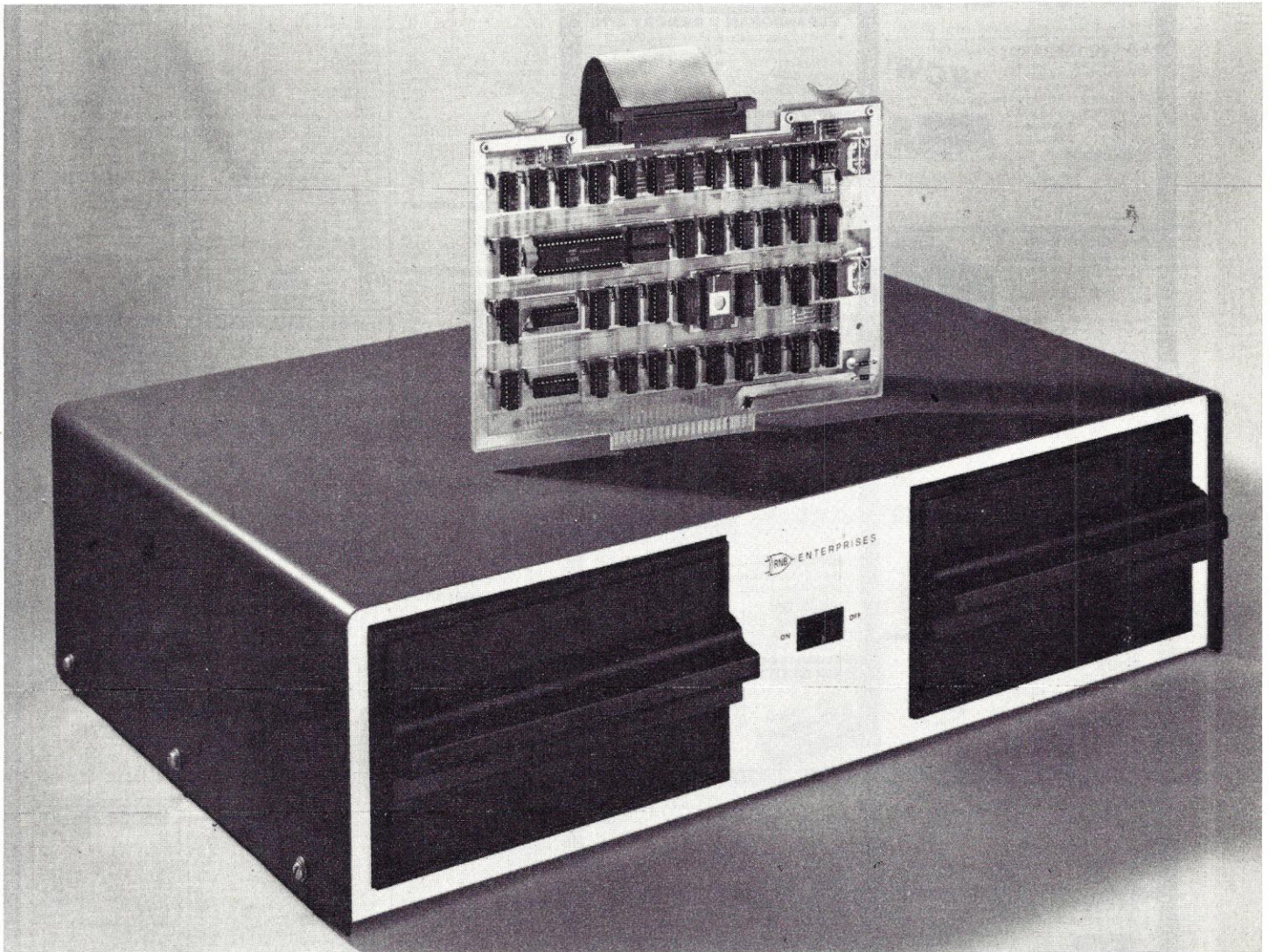
## Calculator Discount Prices

|                           |        |
|---------------------------|--------|
| TI 30 SP                  | 17.95  |
| TI 50                     | 39.95  |
| TI 55                     | 35.95  |
| TI 57                     | 54.95  |
| TI 58C                    | 97.95  |
| TI 59                     | 219.95 |
| TI PC 100C                | 146.95 |
| TI 1035                   | 15.95  |
| TI 1750                   | 19.95  |
| TI 1755                   | 69.95  |
| TI 5040                   | 79.95  |
| TI Data Card              | 26.95  |
| TI Data Chron             | 37.95  |
| TI Business Analyst II    | 42.95  |
| Programmer                | 48.95  |
| TI MBA                    | 57.95  |
| TI Business Card          | 34.95  |
| TI Speak & Spell          | 64.95  |
| TI Dataman                | 19.95  |
| TI Spelling B             | 27.95  |
| Professor                 | 12.95  |
| TI Vowel Power            | 12.95  |
| TI Super Stumpers 4, 5, 6 | 12.95  |
| TI Super Stumpers 7, 8    | 12.95  |









The VAK-7 Disk System was specifically designed for use with AIM-65, SYM-1, and KIM-1 Microcomputer Systems. The VAK-7 will plug directly into the VAK-1 Motherboard or with the addition of regulators into the KIM-4\* Motherboard. The VAK-7 is a complete full size (8") FLOPPY DISK SYSTEM. This system will READ, WRITE, and FORMAT both IBM SINGLE and DUAL DENSITY diskettes. Single-Sided is standard and Dual-Sided is optional. Our Single-Sided drives are set up so they can be converted at a later date to Dual-Sided by the factory, if your storage needs increase.

The VAK-7 system occupies a 4K address space. The system has a 1K block of D.M.A. RAM as a transfer buffer. Also, a 1K block of RAM reserved for D.O.S. pointers, drive status, and catalog information. The remainder of the address is occupied by the resident 2K MINI-DOS. This MINI-DOS is a complete set of subroutines to Read, Write, and Format.



# DISK SYSTEM

The MINI-DOS is not a high level Disk Operating System, but contains all the elementary subroutines for implementation of a high level DOS. Since all the functions are in subroutines, the implementation of this system into a dedicated system is simplified.

## MINI-DOS SUBROUTINES

|                        |                                  |
|------------------------|----------------------------------|
| Block Move             | Read/Write Deleted Data          |
| Seek Track             | Format Disk/Test For Bad Sectors |
| Recalibrate Disk       | Initialize Disk                  |
| Sense Interrupt Status | Physical Copy (Disk to Disk)     |
| Read/Write Data        | Self Test                        |

The VAK-7 is an interrupt driven system, which uses the  $\overline{\text{IRQ}}$  vector. Since this is an interrupt driven system, your system processor is only used to move data into or out of the 1K of DMA RAM, issue the command, and check status at the end of the disk operation. Your system processor is free to do other functions, during disk operations because the intelligent disk controller will complete the operation without tying up valuable processor time.

The VAK-7 System comes complete with Disk Controller Board, Interconnecting Cable, a Cabinet with Power Supply (for two Disk Drives) and one Disk Drive. The VAK-7 Controller can handle up to Four Drives.

## SPECIFICATIONS:

- Completely assembled, tested, and burned in.
- Occupies address \$9000-\$9FFF for AIM-65, \$9000-\$9FFF for SYM-1, or \$E000-\$EFFF for KIM-1.
- IBM Format; Single Density (128 bytes/sector); Dual Density (256, 512, or 1024 bytes/sector).
- All IC's are in sockets.
- Fully buffered address and data bus.
- Standard KIM-4\*BUS (both electrical pin-out and card size).
- Designed for use with a regulated power supply, but has provisions for adding regulators for use with an unregulated power supply.
- Dimensions: Board—10" wide x 7" high (including card-edge)  
Cabinet—23.5" wide x 6.5" high x 16" deep.
- Power Requirements: +5V DC @ 2 Amps.  
117V AC 60Hz @ 2 Amps.

\*KIM-4 is a product of MOS Technology/C.B.M.

## PRICE:

|                       |            |
|-----------------------|------------|
| Single-drive, 1-sided | \$1,299.00 |
| Dual-drive, 1-sided   | 1,898.00   |
| Single-drive, 2-sided | 1,499.00   |
| Dual-drive, 2-sided   | 2,398.00   |

| Plus Shipping | UPS | Mail (APO, FPO) | International |
|---------------|-----|-----------------|---------------|
|---------------|-----|-----------------|---------------|

|              |       |       |                      |
|--------------|-------|-------|----------------------|
| Single Drive | 12.00 | 32.00 | Shipped Air Freight. |
|              |       |       | Freight charges      |
| Dual Drive   | 16.00 | 44.00 | collect.             |

For Alaska and Hawaii, use mail rates.

We manufacture a complete line of high quality expansion boards. Use reader service card to be added to our mailing list, or U.S. residents send \$1.00 (International send \$3.00 U.S.) for airmail delivery of our complete catalog.



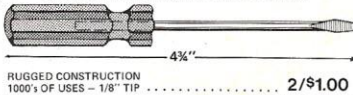
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INCORPORATED

2967 W. Fairmount Avenue  
Phoenix AZ. 85017  
(602)265-7564



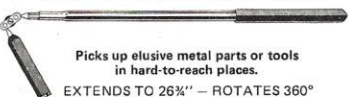


## MINIATURE SCREWDRIVER



RUGGED CONSTRUCTION  
1000's OF USES - 1/8" TIP ..... 2/\$1.00

## MAGNETIC RETRIEVER TOOL



Picks up elusive metal parts or tools  
in hard-to-reach places.  
EXTENDS TO 26 1/2" - ROTATES 360°  
STRONG, LIFETIME MAGNET  
MRT-2281 ..... \$3.95



## CONTINENTAL SPECIALTIES

### LOGIC PROBE KIT



#### SPECIFICATIONS

Input Impedance: 300,000 Ohms.  
Thresholds: "Lo" 30% Vcc - "Hi" 70% Vcc  
Maximum Speed: 300 nsec., 1.5MHz  
Input Protection: ±50VDC continuous 117VAC  
for 15 sec.  
Power: 30mA @ 5V - 40mA @ 15V - 25V max.  
reverse voltage protected; 36" cable with color  
coded clips included.  
Operating Temp.: 0-50°C.  
Dimensions: 5.8L x 1.0W x 0.7D in.  
(147 x 25 x 18mm)  
Weight: 30 oz. (85 gm)  
LPK-1 ..... \$21.95/Kit



### Proto Clips

|             |       |         |
|-------------|-------|---------|
| 14-PIN CLIP | PC-14 | \$ 4.50 |
| 16-PIN CLIP | PC-16 | \$ 4.75 |
| 24-PIN CLIP | PC-24 | \$10.00 |
| 40-PIN CLIP | PC-40 | \$16.00 |

### Proto Boards

|             |         |
|-------------|---------|
| PB-6        | \$17.95 |
| PB-100      | 19.95   |
| PB-101      | 22.95   |
| PB-102      | 26.95   |
| PB-103      | 44.95   |
| PB-104      | 55.95   |
| PB-203      | 99.95   |
| PB-203A     | 155.00  |
| PB-203A-Kit | 131.00  |

### Jumbo 6-Digit Clock Kit

- \* Four .630"ht. and two .300"ht. common anode displays
- \* Uses MM5314 clock chip
- \* Switches for hours, minutes and hold functions
- \* Hours easily viewable to 30 feet
- \* Simulated walnut case
- \* 115VAC operation
- \* 12 or 24 hour operation
- \* Includes all components, case and wall transformer
- \* Size: 6 3/4" x 3 1/8" x 1 1/4"

JE747 ..... \$29.95

### JE701

### 6-Digit Clock Kit \$19.95

### Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to +5V, +9V and +12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3 1/2" x 5" x 2" H

JE200 ..... \$14.95



ADAPTER BOARD  
-Adapts to JE200-  
±5V, ±9V and ±12V

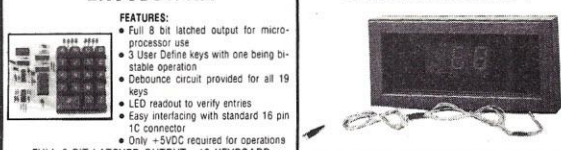
DC/DC converter with +5V input. Toroidal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3 1/2" x 2" x 9/16" H

JE205 ..... \$12.95

## MICROPROCESSOR COMPONENTS

| 8080A/8080A SUPPORT DEVICES  |  | MICROPROCESSOR MANUALS   |  |
|--|--|--|--|
| 8080A  | CPU                                      | \$ 7.95  |  |
| 8212   | 8-Bit Input/Output                       | 3.25   |  |
| 8214   | Priority Interrupt Control               | 3.95   |  |
| 8216   | Bi-Directional Bus Driver                | 3.49   |  |
| 8224   | Clock Generator/Driver                   | 3.95   |  |
| 8226   | Bus Driver                               | 3.49   |  |
| 8228   | System Controller/Bus Driver             | 4.95   |  |
| 8238   | System Controller                        | 5.95   |  |
| 8251   | Prog. Comm. 1/0 (USART)                  | 7.95   |  |
| 8253   | Prog. Interval Timer                     | 14.95  |  |
| 8255   | Prog. Periph. 1/0 (PPI)                  | 9.95   |  |
| 8257   | Prog. DMA Control                        | 19.95  |  |
| 8259   | Prog. Interrupt Control                  | 19.95  |  |
| 6800/6800 SUPPORT DEVICES  |  | ROM'S  |  |
| MC6800   | MPU                                      | \$14.95  |  |
| MC6802CP   | MPU with Clock and Ram                   | 24.95  |  |
| MC6810AP   | 128K Static Ram                          | 5.95   |  |
| MC6821   | Periph. Inter. Adapt (MC6820)            | 7.49   |  |
| MC6828   | Priority Interrupt Controller            | 12.95  |  |
| MC6830L8   | 1024X8 Bit ROM (MC68A30-8)               | 14.95  |  |
| MC6850   | Asynchronous Comm. Adapter               | 7.95   |  |
| MC6852   | Synchronous Serial Data Adapt.           | 9.95   |  |
| MC6860   | 0-600 bps Digital MODEM                  | 12.95  |  |
| MC6862   | 2400 bps Modulator                       | 14.95  |  |
| MC6860A  | Quad 3-State Bus Trans. (MC6T3)          | 2.25   |  |
| MICROPROCESSOR CHIPS-MISCELLANEOUS   |  | RAM'S  |  |
| Z80(780C)  | CPU                                      | \$13.95  |  |
| Z80A(780C)   | CPU                                      | 15.95  |  |
| CDP1802  | CPU                                      | 19.95  |  |
| 2650   | MPU                                      | 19.95  |  |
| 5902   | CPU                                      | 11.95  |  |
| 8035   | 8-Bit MPU w/clock, RAM, 1/0 lines        | 19.95  |  |
| P8085  | CPU                                      | 19.95  |  |
| TMS9900L   | 16-Bit MPU w/hardware, multiply & divide | 49.95  |  |
| SHIFT REGISTERS  |  | MICROPROCESSOR CHIPS-MISCELLANEOUS                                     |  |
| MM500H   | Dual 25 Bit Dynamic                      | \$ 5.50  |  |
| MM503H   | Dual 50 Bit Dynamic                      | 5.50   |  |
| MM504H   | Dual 160 Bit Static                      | 5.50   |  |
| MM510H   | Dual 64 Bit Accumulator                  | 5.50   |  |
| MM516H   | 500/512 Bit Dynamic                      | 8.95   |  |
| 2504T  | 1024 Dynamic                             | 3.95   |  |
| 2518   | Hex 32 Bit Static                        | 4.95   |  |
| 2522   | Dual 132 Bit Static                      | 2.95   |  |
| 2524   | 512 Static                               | .99  |  |
| 2525   | 1024 Dynamic                             | 2.95   |  |
| 2527   | Dual 256 Bit Static                      | 2.95   |  |
| 2528   | Dual 250 Static                          | 4.00   |  |
| 2529   | Dual 240 Bit Static                      | 4.00   |  |
| 2532   | Quad 60 Bit Static                       | 2.95   |  |
| 3341   | File                                     | 6.95   |  |
| 74LS670  | 4K4 Register File (TriState)             | 2.49   |  |
| UART'S   |  | MICROPROCESSOR CHIPS-MISCELLANEOUS                                     |  |
| A-Y-5-1013   | 30K BAUD                                 | 5.95   |  |
| JE600 HEXADECIMAL ENCODER KIT  |  | DIGITAL THERMOMETER KIT  |  |
| FEATURES:  |  | FEATURES:  |  |
| • Full 8 bit latched output for micro-processor use  |  | • Dual sensors-switching control for indoor/outdoor or dual monitoring |  |
| • 3 User Define keys with one being bi-stable operation  |  | • Continuous LED 8" Ht. display  |  |
| • Debounce circuit provided for all 19 keys  |  | • Range: -40°F to 199°F / -40°C to 100°C                               |  |
| • LED readout to verify entries  |  | • Accuracy: ±1°F nominal   |  |
| • Easy interfacing with standard 16 pin 1C connector   |  | • Set for Fahrenheit or Celsius reading                                |  |
| • Only +5VDC required for operations   |  | • Sim. walnut case - AC wall adapter incl.                             |  |
| FULL 8 BIT LATCHED OUTPUT-19 KEYBOARD  |  | • Size: 3-1/4" H x 6-5/8" W x 1-3/8" D                                 |  |
| The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry sheet. |  | • Dual sensors-switching control for indoor/outdoor or dual monitoring |  |
| JE600 ..... \$59.95  |  | • Continuous LED 8" Ht. display  |  |
| Hexadecimal Keypad only ..... \$14.95  |  | • Range: -40°F to 199°F / -40°C to 100°C                               |  |
| JE300 ..... \$39.95  |  | • Accuracy: ±1°F nominal   |  |
| Hexadecimal Keypad only ..... \$14.95  |  | • Set for Fahrenheit or Celsius reading                                |  |
| JE300 ..... \$39.95  |  | • Sim. walnut case - AC wall adapter incl.                             |  |
| Hexadecimal Keypad only ..... \$14.95  |  | • Size: 3-1/4" H x 6-5/8" W x 1-3/8" D                                 |  |

## 62-Key ASCII Encoded Keyboard Kit



FEATURES:  
• 60 Keys generate the full 128 characters, upper and lower case ASCII  
• Fully buffered  
• 2 user-define keys provided for custom applications  
• Caps lock for upper case only alpha characters  
• Utilizes a 2376 (40 pin) encoder read only memory chip  
• Outputs directly compatible with TTL/DTL or MOS logic arrays  
• Easy interfacing with a 16-pin dip or 18-pin edge connector

JE610 ..... \$79.95  
62-Key Keyboard only . . \$34.95

## HICKOK LX303 Portable LCD Digital Multimeter



• Big 1 1/2 inch high 3 1/2" Digit Liquid Crystal Display • Over 200 hours of operation with a 9V battery  
• Automatic zero, polarity and overrange indication • 100mV DC F.S. sensitivity • 1% basic accuracy  
• 19 ranges and functions • Rugged Cyclacase and removable cover, stores test lead set.  
• Full one year warranty.

SPECIFICATIONS: DC volts (5 range): 0.1V to 1000V. Accuracy: ±0.5% rdg ±0.5% f.s. Input imped: 100kΩ  
Max. input 1A except 600V on 200mV range  
AC Volts (4 range): 0.1V to 600V. Accuracy: ±1.0% rdg ±0.5% f.s. - 200 max. on 50kV; Max. input: 600V  
Resistance (5 Low Power Range): 0.1 to 20MΩ. Accuracy: ±0.5% rdg ±0.5% f.s. (5.1V rdg on 20MΩ range)  
Input protection to 120VAC at 100mA  
DC Current (5 range): 0.1mA to 100mA. Accuracy: ±1.0% rdg ±0.5% f.s.  
Dimensions and Weight: 5.7" H x 3.3" W x 1.3" D, 8.0 oz. P0268 9V battery (not included) or Hickok AC adapter  
READ RATE: 3/sec

LX303 Digital Multimeter ..... \$74.95

| PART NO. | DESCRIPTION                      | PRICE |
|----------|----------------------------------|-------|
| RC-3     | 115V AC ADAPTER                  | 7.50  |
| CC-3     | PADDED CARRYING CASE             | 7.50  |
| VP-10    | X10 DC PROBE ADAPTER (Up to 10K) | 14.95 |
| VP-40    | 40kV DC PROBE                    | 35.00 |
| CS-1     | 10 Amp DC Current Shunt          | 14.95 |

\$10.00 Min. Order - U.S. Funds Only  
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Spec Sheets - 25¢  
1980 Catalog Available - Send 41¢ stamp

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## The Incredible "Pennywhistle 103"



**\$139.95 Kit Only**

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modern and terminal for telephone "hacking" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method ..... Frequency-Shift Keying, full-duplex (half-duplex selectable).

Maximum Data Rate ..... 300 Baud.

Data Format ..... Asynchronous Serial (return to mark level required between each character).

Receive Channel Frequencies ..... 2025 Hz for space; 2225 Hz for mark.

Transmit Channel Frequencies ..... Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark.

Receive Sensitivity ..... -46 dbm acoustically coupled.

Transmit Level ..... -15 dbm nominal. Adjustable from -6 dbm to -20 dbm.

Receive Frequency Tolerance ..... Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.

Digital Data Interface ..... EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).

Power Requirements ..... 120 VAC, single phase, 10 Watts.

Physical ..... All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

## TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.  
Kit comes complete with:  
• 8 each UPD416-1 (16K Dynamic Rams) 250NS  
• Documentation for conversion

TRS-16K ..... \$75.00

**ok JUST WRAP™**

• 30 AWG wire • .025" square posts  
• Daisy chain or • Built-in cut off  
• point-to-point • Includes 50 ft. wire  
• No stripping or • slitting required - just wrap

| Part No. | Color  | Price   |
|----------|--------|---------|
| JW-1-B   | Blue   | \$14.95 |
| JW-1-W   | White  | 14.95   |
| JW-1-Y   | Yellow | 14.95   |
| JW-1-R   | Red    | 14.95   |

## JUST WRAP™ Replacement Wire

| Part No. | Color  | 50 ft. roll | Price  |
|----------|--------|-------------|--------|
| R-JW-B   | Blue   | 50 ft. roll | \$2.98 |
| R-JW-W   | White  | 50 ft. roll | 2.98   |
| R-JW-Y   | Yellow | 50 ft. roll | 2.98   |
| R-JW-R   | Red    | 50 ft. roll | 2.98   |

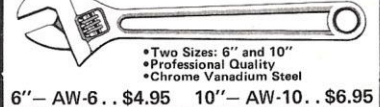
## JUST WRAP™ Unwrap Tool \$3.49

**ok Vacuum Vise**

Vacuum-based light-duty vise for small components and assemblies. ABS construction. 1 1/2" jaws, 1 1/2" travel. Can be permanently installed.

VV-1 ..... \$3.49

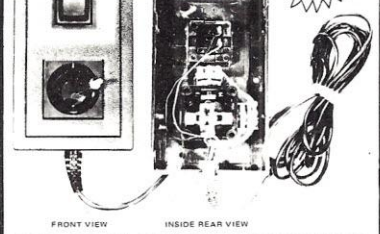
## ADJUSTABLE WRENCH



• Two Sizes: 6" and 10"  
• Professional Quality  
• Chrome Vanadium Steel

6" - AW-6 .. \$4.95 10" - AW-10 .. \$6.95

## JOYSTICK VIDEO CONTROLLER



• IDEAL FOR ALL VIDEO GAMES OR REMOTE CONTROL PROJECTS  
• SMALL CASE SIZE: 1-1/2" H x 2-3/8" W x 4-5/16" L  
• 2 MINIATURE POTENTIOMETERS-40K OHM EACH  
• SPST PUSH BUTTON CONTROL  
• 5-WIRE CONNECTION CABLE - 5 FEET LONG  
• RUGGED PLASTIC CASE

JVC-40 ..... \$4.95 each



| 7400 TTL |     |         |      |
|----------|-----|---------|------|
| SN7400N  | .20 | SN7400N | .29  |
| SN7401N  | .20 | SN7401N | .29  |
| SN7402N  | .20 | SN7402N | .29  |
| SN7403N  | .20 | SN7403N | .29  |
| SN7404N  | .25 | SN7404N | 5.00 |
| SN7405N  | .20 | SN7405N | .50  |
| SN7406N  | .29 | SN7406N | .29  |
| SN7407N  | .29 | SN7407N | .29  |
| SN7408N  | .29 | SN7408N | .29  |
| SN7409N  | .20 | SN7409N | .29  |
| SN7410N  | .18 | SN7410N | .175 |
| SN7411N  | .25 | SN7411N | .45  |
| SN7412N  | .25 | SN7412N | .59  |
| SN7413N  | .40 | SN7413N | .43  |
| SN7414N  | .20 | SN7414N | .43  |
| SN7415N  | .20 | SN7415N | .65  |
| SN7416N  | .20 | SN7416N | .65  |
| SN7417N  | .25 | SN7417N | .95  |
| SN7418N  | .25 | SN7418N | .95  |
| SN7419N  | .25 | SN7419N | .95  |
| SN7420N  | .20 | SN7420N | .95  |
| SN7421N  | .29 | SN7421N | 1.00 |
| SN7422N  | .39 | SN7422N | 1.25 |
| SN7423N  | .25 | SN7423N | .59  |
| SN7424N  | .29 | SN7424N | .35  |
| SN7425N  | .29 | SN7425N | .35  |
| SN7426N  | .29 | SN7426N | 1.95 |
| SN7427N  | .29 | SN7427N | .35  |
| SN7428N  | .39 | SN7428N | .39  |
| SN7429N  | .39 | SN7429N | .39  |
| SN7430N  | .20 | SN7430N | .20  |
| SN7431N  | .25 | SN7431N | .25  |
| SN7432N  | .25 | SN7432N | .25  |
| SN7433N  | .40 | SN7433N | .40  |
| SN7434N  | .20 | SN7434N | .20  |
| SN7435N  | .20 | SN7435N | .20  |
| SN7436N  | .20 | SN7436N | .20  |
| SN7437N  | .20 | SN7437N | .20  |
| SN7438N  | .20 | SN7438N | .20  |
| SN7439N  | .20 | SN7439N | .20  |
| SN7440N  | .20 | SN7440N | .20  |
| SN7441N  | .20 | SN7441N | .20  |
| SN7442N  | .20 | SN7442N | .20  |
| SN7443N  | .20 | SN7443N | .20  |
| SN7444N  | .20 | SN7444N | .20  |
| SN7445N  | .20 | SN7445N | .20  |
| SN7446N  | .20 | SN7446N | .20  |
| SN7447N  | .20 | SN7447N | .20  |
| SN7448N  | .20 | SN7448N | .20  |
| SN7449N  | .20 | SN7449N | .20  |
| SN7450N  | .20 | SN7450N | .20  |
| SN7451N  | .20 | SN7451N | .20  |
| SN7452N  | .20 | SN7452N | .20  |
| SN7453N  | .20 | SN7453N | .20  |
| SN7454N  | .20 | SN7454N | .20  |
| SN7455A  | .25 | SN7455A | .25  |
| SN7460N  | .20 | SN7460N | .20  |
|          |     | SN7460N | .89  |
|          |     | SN7461N | .89  |
|          |     | SN7462N | 1.95 |
|          |     | SN7463N | .89  |
|          |     | SN7464N | .89  |
|          |     | SN7465N | .89  |
|          |     | SN7466N | 1.25 |
|          |     | SN7467N | 1.95 |
|          |     | SN7468N | 1.95 |
|          |     | SN7469N | 5.00 |
|          |     | SN7470N | 1.25 |
|          |     | SN7471N | 1.00 |
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## Cromemco

### Z80-4MHz Single Card Computer

Cromemco's Single Card Computer is a complete computer which brings the power of the Z80 and the flexibility of the S-100 into the dedicated computer environment.

The card offers 4MHz operation, 8K bytes of on-board 2716 PROM, and 1K bytes of static RAM memory. This stand-alone card also provides an RS-232 for 2400 baud serial interface with programmable baud rate to 9600, vectored interrupt, 24 lines of bidirectional parallel I/O, and 5 pins for expansion. Only a power supply and PROM software are required for operation. The Single Card Computer is assembled and tested (Model SCC-8) for \$450. The Monitor and Control BASIC are available in two ROM's (Model MC8-216) for \$90.

### SCC-W (Assembled) ..... \$450.00

**Processor:** 4MHz Z80  
**Instruction Set:** 158 instructions incl. the 78 instructions of the 8080  
**ROM Capacity:** 8K Bytes located from address 0000 to 1FFF  
**RAM Capacity:** 1K Bytes located from address 8000 to 9FFF  
**RAM Type:** 4045, Static

**Serial I/O Ports:**  
 I/O Lines: RS-232 or 20mA current loop  
 Baud Rates: 110 to 9600 (software selectable)  
**Parallel Ports:**  
 Input Port: 24 bit bidirectional  
 Output Port: 24 bit bidirectional  
 Input Load: 50 ohm TTL equivalent  
 Output Drive: 20 TTL loads  
 Interrupt Lines: Number of interrupts: 5

**Timer range:** 0.16-32 milliseconds (software set)  
**Time resolution:** 64 microseconds  
**Vectored Interrupts:**  
 No. of vector locations: 128 (8080), 65,536 (General Interrupt)  
**UART:** Type 3801 Bus: S-100  
**Power requirements:**  
 +5V at 1.4A  
 +12V at 70mA  
 -10V at 25mA  
 Operating environment: 0-50°C

### DISCRETE LEDS

|                     |      |                     |      |                     |      |
|---------------------|------|---------------------|------|---------------------|------|
| XC556R .200" red    | 5/51 | MV50 .085" red      | 6/51 | XC111R .190" red    | 5/51 |
| XC556G .200" green  | 4/51 | XC209R .125" red    | 5/51 | XC111G .190" green  | 4/51 |
| XC556Y .200" yellow | 4/51 | XC209G .125" green  | 4/51 | XC111Y .190" yellow | 4/51 |
| XC556B .200" blue   | 4/51 | XC209Y .125" yellow | 4/51 | XC111B .190" blue   | 4/51 |
| XC22R .200" red     | 5/51 | XC256R .185" red    | 5/51 |                     |      |
| XC22G .200" green   | 4/51 | XC256G .185" green  | 4/51 |                     |      |
| XC22Y .200" yellow  | 4/51 | XC256Y .185" yellow | 4/51 |                     |      |
| MV10B .170" red     | 4/51 | XC256B .185" blue   | 4/51 |                     |      |

**INFRARED LED**  
 4"x5"x1/16" flat 5/51

### DISPLAY LEDS

| TYPE     | POLARITY                 | HT   | PRICE | TYPE     | POLARITY                | HT   | PRICE |
|----------|--------------------------|------|-------|----------|-------------------------|------|-------|
| MAN 1    | Common Anode-red         | .270 | 2.55  | MAN 6730 | Common Anode-red ± 1    | .560 | .99   |
| MAN 2    | 5 x 7 Dot Matrix-red     | .300 | 4.95  | MAN 6740 | Common Cathode-red-D.D. | .560 | .99   |
| MAN 3    | Common Cathode-red       | .125 | .25   | MAN 6750 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 4    | Common Cathode-red       | .187 | 1.95  | MAN 6760 | Common Anode-red        | .560 | .99   |
| MAN 7    | Common Anode-green       | .300 | 1.25  | MAN 6780 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 8    | Common Cathode-orange    | .300 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 72   | Common Anode-red         | .300 | .75   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 74   | Common Cathode-red       | .300 | 1.25  | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 82   | Common Anode-yellow      | .300 | .49   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 84   | Common Cathode-orange    | .300 | .49   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 3820 | Common Anode-orange      | .300 | .49   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 3830 | Common Anode-red ± 1     | .300 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 3840 | Common Cathode-orange    | .300 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 4010 | Common Anode-orange      | .300 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 4640 | Common Cathode-orange    | .300 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 4710 | Common Anode-red         | .400 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 4730 | Common Anode-red ± 1     | .400 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 4810 | Common Cathode-red       | .400 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 4840 | Common Cathode-yellow    | .400 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 6610 | Common Anode-orange-D.D. | .560 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 6650 | Common Anode-orange ± 1  | .560 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 6680 | Common Anode-orange      | .560 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |
| MAN 6710 | Common Anode-red-D.D.    | .560 | .99   | MAN 6790 | Common Cathode-red ± 1  | .560 | .99   |

| RCA LINEAR |      |         | CALCULATOR CHIPS/DRIVERS |        |        | CLOCK CHIPS |      |          | MOTOROLA |  |  |
|------------|------|---------|--------------------------|--------|--------|-------------|------|----------|----------|--|--|
| CA301J     | 2.15 | CA3082N | 2.00                     | MM5725 | \$2.95 | MM5309      | 4.95 | MC1408L7 | 4.95     |  |  |
| CA302J     | 2.25 | CA3083N | 1.80                     | MM5728 | 2.95   | MM5311      | 4.95 | MC1408L8 | 5.75     |  |  |
| CA303J     | 2.48 | CA3084N | 1.65                     | DM8875 | 2.00   | MM5312      | 4.95 | MC1439L  | 2.95     |  |  |
| CA304J     | 1.35 | CA3085N | 1.35                     | DM8876 | 1.00   | MM5313      | 4.95 | MC1440L  | 2.95     |  |  |
| CA305J     | 1.30 | CA3086N | 1.30                     | DM8877 | .75    | MM5314      | 4.95 | MC1441L  | 2.95     |  |  |
| CA306J     | 1.35 | CA3087N | 1.35                     | DM8878 | .75    | MM5315      | 4.95 | MC1442L  | 2.95     |  |  |
| CA307J     | 1.35 | CA3088N | 1.35                     | DM8879 | .75    | MM5316      | 4.95 | MC1443L  | 2.95     |  |  |
| CA308J     | 1.25 | CA3089N | 1.25                     | DM8880 | .75    | MM5317      | 4.95 | MC1444L  | 2.95     |  |  |
| CA309J     | 1.25 | CA3090N | 1.25                     | DM8881 | .75    | MM5318      | 4.95 | MC1445L  | 2.95     |  |  |
| CA310J     | 2.00 | CA3091N | 2.00                     | DM8882 | .75    | MM5319      | 4.95 | MC1446L  | 2.95     |  |  |

LOW PROFILE  
(TIN) SOCKETS

|           | 1-24 | 25-49 | 50-100 |
|-----------|------|-------|--------|
| 8 pin LP  | .17  | .16   | .15    |
| 14 pin LP | .20  | .19   | .18    |
| 16 pin LP | .22  | .21   | .20    |
| 18 pin LP | .29  | .28   | .27    |
| 20 pin LP | .34  | .32   | .30    |
| 22 pin LP | .37  | .36   | .35    |
| 24 pin LP | .38  | .37   | .36    |
| 28 pin LP | .45  | .44   | .43    |
| 36 pin LP | .60  | .59   | .58    |
| 40 pin LP | .63  | .62   | .61    |

SOLDER TAIL  
STANDARD (TIN)

|           | 1-24 | 25-49 | 50-100 |
|-----------|------|-------|--------|
| 14 pin ST | .27  | .25   | .24    |
| 16 pin ST | .30  | .27   | .25    |
| 18 pin ST | .33  | .32   | .30    |
| 24 pin ST | .40  | .35   | .32    |
| 28 pin ST | .45  | .40   | .37    |
| 36 pin ST | 1.39 | 1.26  | 1.15   |
| 40 pin ST | 1.59 | 1.45  | 1.30   |

SOLDER TAIL (GOLD)  
STANDARD

|           | 1-24 | 25-49 | 50-100 |
|-----------|------|-------|--------|
| 8 pin SG  | .39  | .35   | .31    |
| 14 pin SG | .49  | .45   | .41    |
| 16 pin SG | .54  | .49   | .44    |
| 18 pin SG | .59  | .53   | .48    |
| 24 pin SG | .75  | .71   | .67    |
| 28 pin SG | 1.10 | 1.00  | .90    |
| 36 pin SG | 1.65 | 1.40  | 1.26   |
| 40 pin SG | 1.75 | 1.59  | 1.45   |

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|           | 1-24 | 25-49 | 50-100 |
|-----------|------|-------|--------|
| 8 pin WW  | .59  | .54   | .49    |
| 10 pin WW | .69  | .63   | .58    |
| 14 pin WW | .79  | .73   | .67    |
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| 20 pin WW | 1.19 | 1.08  | .99    |
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|----------|-------|--------|--------|--------|---------|---------|----------|
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| ASST. 2  | 5 ea. | 10 ea. | 20 ea. | 50 ea. | 100 ea. | 500 ea. | 1000 ea. |
| ASST. 3  | 5 ea. | 10 ea. | 20 ea. | 50 ea. | 100 ea. | 500 ea. | 1000 ea. |
| ASST. 4  | 5 ea. | 10 ea. | 20 ea. | 50 ea. | 100 ea. | 500 ea. | 1000 ea. |
| ASST. 5  | 5 ea. | 10 ea. | 20 ea. | 50 ea. | 100 ea. | 500 ea. | 1000 ea. |
| ASST. 6  | 5 ea. | 10 ea. | 20 ea. | 50 ea. | 100 ea. | 500 ea. | 1000 ea. |
| ASST. 7  | 5 ea. | 10 ea. | 20 ea. | 50 ea. | 100 ea. | 500 ea. | 1000 ea. |
| ASST. 8R | 5 ea. | 10 ea. | 20 ea. | 50 ea. | 100 ea. | 500 ea. | 1000 ea. |

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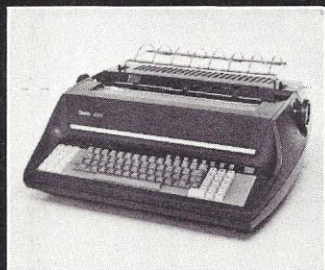
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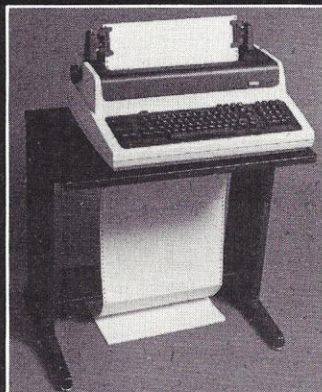
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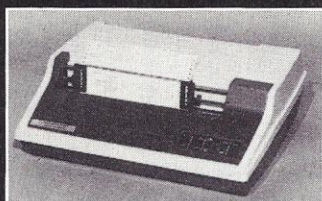
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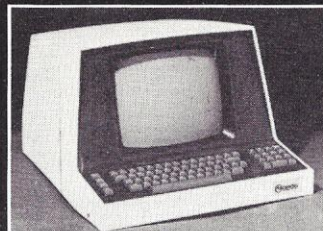
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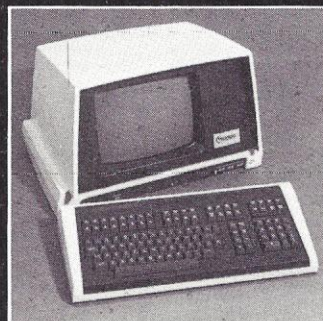
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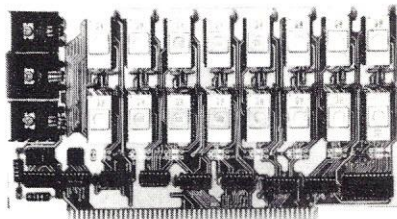
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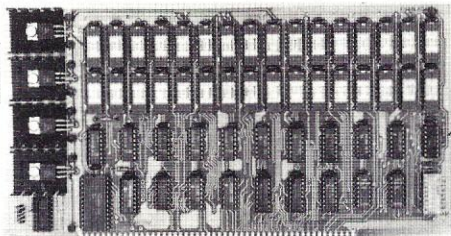
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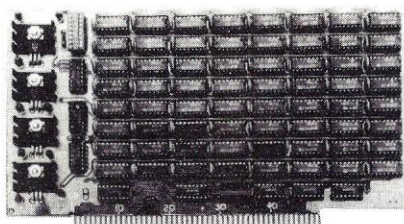
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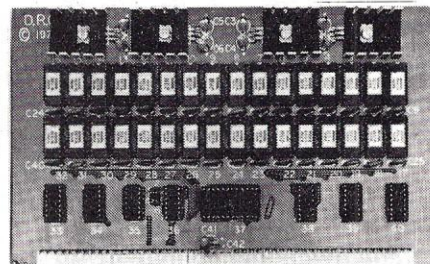
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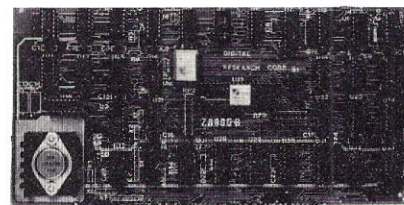
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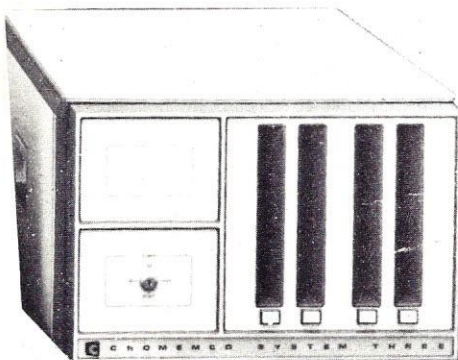
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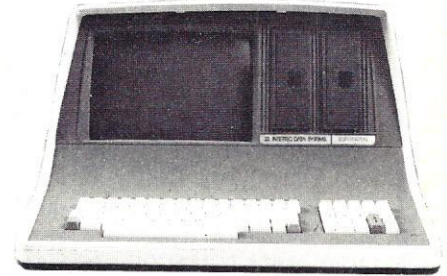
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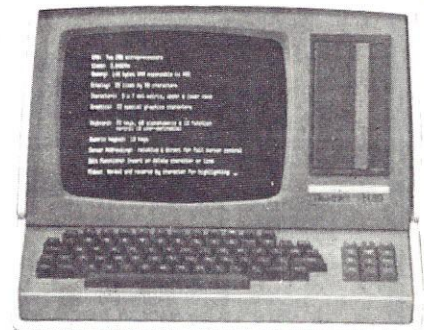
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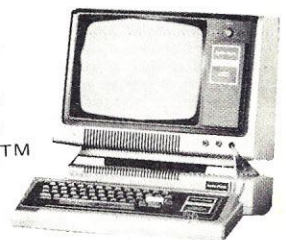
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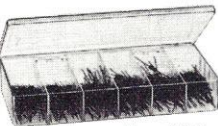
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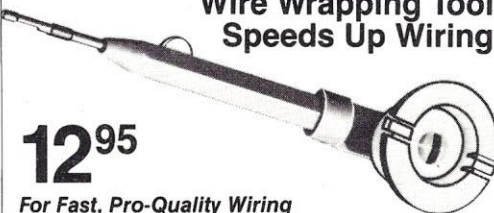


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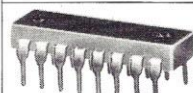
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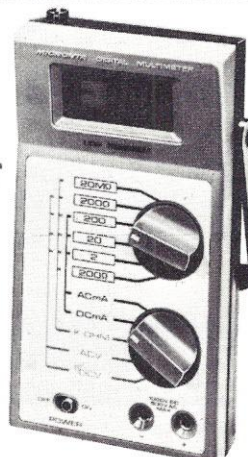
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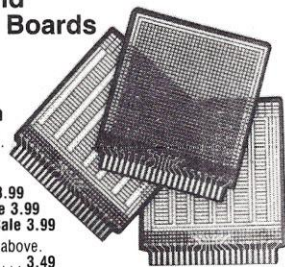
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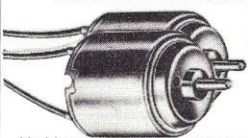
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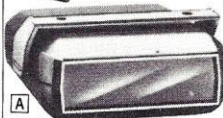
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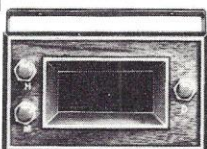
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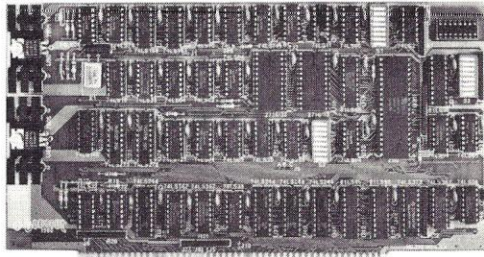


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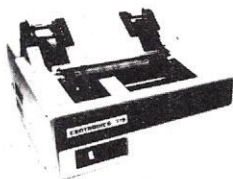
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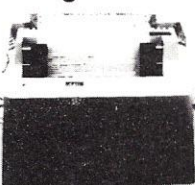
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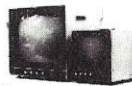
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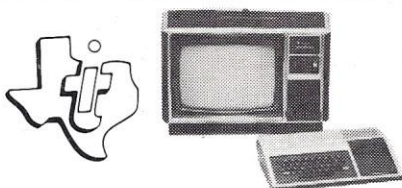
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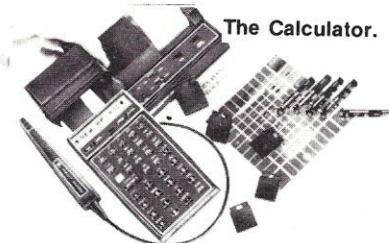
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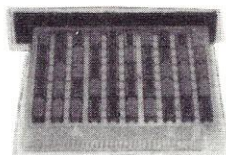
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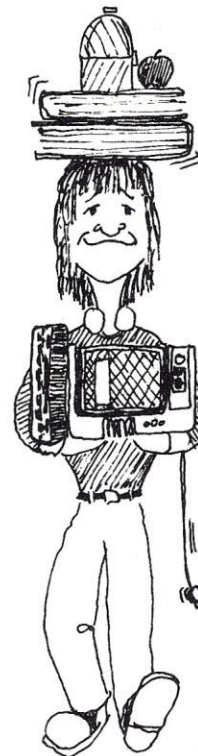
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In June, school is out for the summer, and teachers have to start preparing for the next academic year. The June issue of *Kilobaud Microcomputing* will feature a special section on microcomputers in education, written by educators and computerists. Articles and programs will provide overviews and specific applications for educators already using microcomputers as educational tools, or for those contemplating introducing microcomputers into the curriculum.

Topics will include:

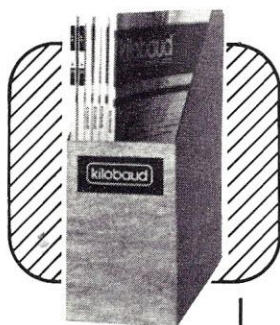
- *math and science programs*
- *a computerized gradebook*
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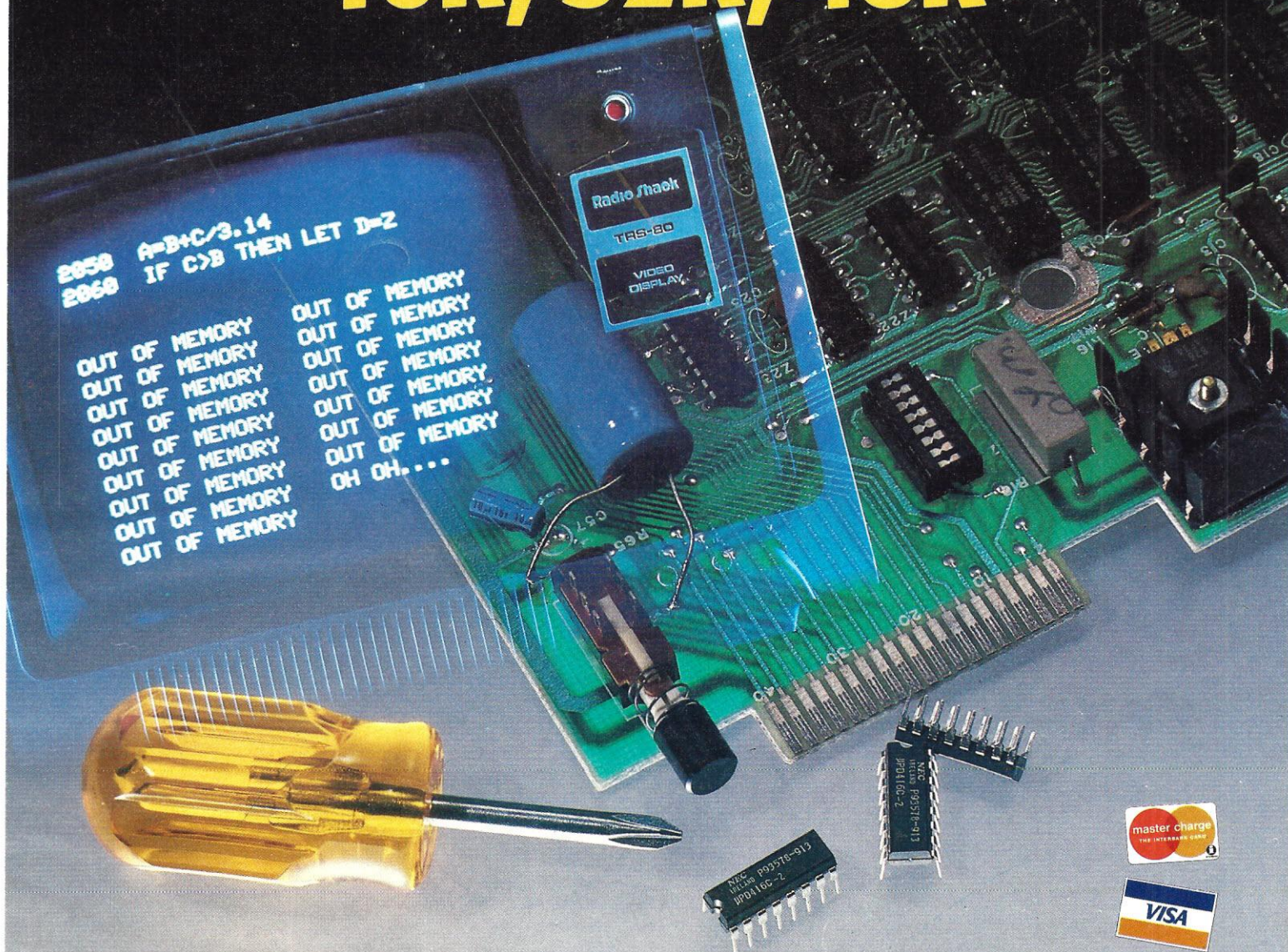
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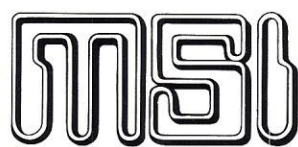
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